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The Relative Economy of High-Duty Pumping Engines—The Daimler Petroleum Motor—Churchill Rail Joint—High Speed Locomotives—Rolling Rails and Reheating—The Flow of Water Over Wide-Topped Dams (*illustrated*)—The Pelton Water-Wheel and Atkins Turbine Patent (*illustrated*).

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Extensions of the old two-mile, and of the breakwater tunnel of the Chicago water-works are reported as proposed. It is said that the City Engineer, Mr. L. H. Clark has been instructed to prepare plans for the extensions.

A fast run on the Chicago & Alton R. R. was noted in our issue of Dec. 15, and we are indebted to Mr. T. M. Bates, Superintendent of Transportation, for the official schedule. The run was made Dec. 1 from Chicago to Springfield, with four Baltimore & Ohio R. R. cars. The track is ballasted with gravel from Chicago to Bloomington, and with stone and cinders from Bloomington to Springfield. The distance is 185 miles, and was made in 4 h. 14 min. (5 a. m. to 9:14 a. m.), or, deducting 20 min. for stops, 3 h. 54 min. actual running time, giving an average speed of 49.55 miles per hour (72.65 sec. per mile) between stops, or an average of 82.4 sec. per mile, or 43.7 miles per hour for the entire run of 185 miles in 4 h. 14 min. The 34.6 miles between Pontiac and Bloomington were made in 41 min., including three dead stops; and the 51.3 miles from Bloomington to Sherman were made in 60 min., including three dead stops; deducting 3 min. in each case for stops this gives a running speed of about 54.5 miles per hour. The train was run on a telegraph schedule, as used by roads using the standard code, and there was no previous arrangement for a fast run. There were several stops and slackening of speed for crossings. The engineman claimed that the schedule was not fast enough, and Mr. Bates states that there was nothing extraordinary in the run, which could have been made quicker if desired.

Proposals have been received recently by Gen. O. M. Poe, U. S. Engineers, for dredging the bar at the mouth of the Detroit River, and the extremely low bid of 18 cts. per cu. yd., scow measure, was made by L. P. & J. A. Smith, of Cleveland, O. The other bids ranged from 28 cts. to 74 cts. The work is section 8 of the deep water channel from Duluth and Chicago to Buffalo, and is the excavation of a 21-ft. channel with a minimum width at the bottom of 300 ft., and a length of 26,500 ft., but if the price bid warrants the engineer officer may require the bottom width increased to 300 ft. The estimated excavation for the minimum is 411,000 cu. yds., and for the maximum 1,086,000 cu. yds. The material to be removed is sand, clay, gravel and boulders. On sections 6 and 7 the lowest bids were respectively 16½ cts., by J. Rooney, of Toledo, O., and 14⅞ cts., by Breymann Bros., of Toledo, O. The bids are given in our construction columns.

The test of the comparative holding power of cut nails and wire nails recently made at the Watertown Arsenal showed the cut nail to have considerably greater resistance. The following is the record of some of the tests:

	Comparative holding power, lbs.				
Wire nail.....	733	673	675	594	879
Cut nail.....	836	742	804	964	1,200
Difference.....	103	69	129	370	321

A discovery of nickel in Iowa has been reported recently in the daily papers, with much elaboration of the importance of the discovery, as in the case of the Oregon deposits noted in our issue of May 19, 1892. We are indebted to Mr. C. R. Keyes, Assistant Geologist of the Iowa Geological Survey, for the following official statement, which shows that there is no commercial importance in the Iowa deposits:

A large quarry recently opened near the city of Keokuk, in the lower carboniferous limestone, disclosed numerous cavities lined with calcite. On some of the crystals there have been found beautiful tufts of closely arranged, brass-yellow needles of millerite pointing from the center of attachment in all directions to a distance of ½ to 2½ ins. In some of the examples the tufts are made up of hundreds of filaments, often so close together that the needles of the different bunches are interwoven, forming a dense matted mass. Often a large perfectly transparent calcite has tufts of long millerites completely inclosed in it, after the manner of the fleches d'amour rutile needles in quartz. Or a part of the tuft may be embedded in the lime crystal and the extremities of the needles left projecting outside. While this is believed to be the first occurrence of any of the nickel-bearing minerals reported from the state it is not at all probable that the "find" will ever prove of any great economic importance. There is no doubt, however, that from a mineralogical standpoint the Iowa millerite is among the most beautiful ever found in this country if not in the world.

The most serious railway accident of the week was a rear collision Dec. 18, at Nelson, Minn., on the Great Northern Ry. A wrecking train that had been removing cars wrecked in a collision on Dec. 16 was preparing to start east, and the caboose and several cars were standing on the main track. An eastbound freight train ran into the cars, telescoping the caboose, and the wreck caught fire. There were 14 men in the caboose, of whom 8 were killed and burned, and 5 were injured. There was no flagman out, but the freight train had order to sidetrack at this place to let a westbound passenger train pass.

The Harlem River drawbridge of the New York Central R. R. was blocked by a log caught in the machinery, Dec. 20, and it was an hour before it could be removed and the bridge closed. The log was being used in the repair of the structure.—A derailed car last week damaged the Arkansas River drawbridge at Little Rock, Ark., so that trains cannot pass, and the draw cannot be operated.

A car heater in a chair car on the Cincinnati, Hamilton & Dayton R. R. exploded Dec. 11 while the train was running near Wapakoneta, O. Nobody was injured.

A 36-in. water main burst recently in Chicago, flooding cellars and doing considerable damage. No satisfactory explanation of the cause of the break is given.

The main shaft of pumping engine No. 3 of the Brooklyn water-works broke Nov. 13. Owing to the heating of the crank pin the engineers suspected that something was wrong, and the engine was running slowly when the break occurred. The pump had a daily capacity of about 15,000,000 gallons, and its disabling is likely to make the water supply short for four or five weeks. Commissioner of Public Works John P. Adams, Chief Engineer Robert Van Buren, and Mayor D. A. Boody, have for some months been urging the aldermen to authorise the purchase of additional pumps.

The need for greater braking power on high speed trains has been frequently pointed out. The difficulty in quickly stopping a high speed train arises not only from the enormous energy stored in it, which varies as the square of the speed, but from the reduced retardation of the brakes at high speeds. Many years ago Mr. Geo. Westinghouse devised an ingenious apparatus by which the pressure on the brake shoes was varied, being greatest at high speeds, and reducing regularly with the speed. With this apparatus, a nearly constant coefficient of retardation, averaging over 0.20 for the whole stop, was obtained; but at that time the device was not considered commercially practicable. The number of high speed trains now running in this country, however, and the fact that the present brake efficiency is a principal limit to higher speeds has led the Westinghouse Brake Co. to take up the matter again, and a brake designed especially for high speed trains has been developed and was tested on Dec. 7 at Altoona, Pa. A train of six passenger coaches and a dynamometer car was stopped from various speeds, first with the ordinary quick-acting brake and then with the high speed brake. The result of the tests showed that a stop could be made with the high speed brake in about three-fourths of the distance required with the ordinary quick action brake, as noted elsewhere.

The apparatus is not especially complicated or expensive and can be applied to any car fitted with the ordinary quick action brake, with no material changes. In fact the apparatus is so designed that it is entirely inoperative in ordinary service stops and is only brought into play when the engineer's valve is turned to the emergency position. Some details remain to be perfected and the apparatus is not yet on the market; but it is hoped that it may be soon.

The purification of boiler feed water by chemical treatment seems to be growing in favor. In our issue of Dec. 5, 1891, we described the system in use on the Chicago, Milwaukee & St. Paul Ry., in which a purge is introduced into the boiler with the feed and the sediment is got rid of by blowing off. On June 9, 1892, we showed the Pennell system, in which the chemicals are put into the supply tank and the sediment, which settles to the bottom, is flushed off. The latest feed-water purifying system is brought out by Bradley & Co., of Syracuse, N. Y. The chemical precipitant, soda ash (sodium carbonate), is added to the feed water after it has passed through the heater, and it is then forced through a sand filter, arranged on the same principle as the well known Hyatt and National filters, which removes the sediment. A secondary precipitation takes place in the boilers, however, as the result of evaporation, and this is disposed of by leading a small pipe from the surface blow-off of the boiler to the filter and forcing a circulation through it by a small pump. This apparatus is in use in nine different establishments in Syracuse, purifying waters carrying 22 to 42 grains per gallon of scale producing substances, and is giving, we understand, perfect satisfaction. The manufacturers guarantee absolutely the satisfactory performance of the apparatus as demonstrated by an analysis of water drawn from the boiler.

The statistics collected by the American Railway Association of the use on freight cars of automatic couplers of the M. C. B. type and air brakes show fair progress in both these reforms. The following table compares the statistics obtained on Feb. 15, and those obtained on Oct. 1:

	1892. Feb. 15,	1892. Oct. 1,
Total No. of cars reported.....	703,823	885,351
No. equipped with M. C. B. couplers...	148,400	200,753
Percentage of total reported.....	16.8	22.6
No. equipped with air brakes.....	88,497	144,981
Percentage of total reported.....	12.5	16.3
Cars reported under construction.....	.....	11,484
No. to have M. C. B. couplers.....	.....	9,709
Percentage of total reported.....	.....	85.3
No. to have air brakes.....	.....	7,934
Percentage of total reported.....	.....	69.1
Total locomotives reported.....	.....	26,090
No. equipped with power brakes.....	.....	23,985
Percentage of total reported.....	.....	89.5

Besides the above cars, the committee had reports last February from private companies that 17,700 cars owned by them were equipped with automatic couplers. This makes a grand total of 228,252 cars equipped with automatic couplers, including the cars now under construction but not including some 400,000 cars from which no reports were received. According to these figures the proportion of freight rolling stock fitted with M. C. B. couplers is increasing at the rate of 8.2% per annum, and the proportion equipped with air brakes at the rate of 5.4% per annum. These figures alone would indicate that some 9 years will be required to complete the equipment with couplers, and about 16 years to complete the equipment with brakes. There is no doubt, however, that both these improvements will be rapidly accelerated, now that their necessity is well established. The fact that 70% of the new equipment is receiving air brakes, and 85% has M. C. B. couplers, is a most gratifying one.

Continuous brakes are now practically universal on English railways. In 1878, 87% of the engines were not fitted with continuous brakes which complied wholly or in part with the Board of Trade requirements, and 81% of the cars were similarly unprotected. In the year ending June 30, 1891, only 3% of the engines and 4% of the cars were unprovided with this protection, while on June 30, 1892, 98% of the engines, and 97% of the cars were fitted with continuous brakes complying wholly or partly with the Board of Trade requirements. Of the total mileage run by the railways of the United Kingdom, 97% was performed by trains fitted with continuous brakes, the remaining 3% being principally on small or branch lines. The Westinghouse and the Vacuum automatic brakes are used almost exclusively.

THE NEW HIGH-DUTY PUMPING ENGINE OF THE BOSTON WATER-WORKS.

(With inset.)

The city of Boston has made a notable departure from the general practice in its purchase of a new high service pumping engine. It is especially noteworthy since it is a return to a practice which prevailed with reference to the purchase of pumping engines from the first use of steam pumping engines in this country down to a time well within the memory of engineers still in active practice.

At the present time a city or a water company desiring a new pumping engine has only to let the fact be known, and the representatives of half a dozen great firms making a specialty of such work, will appear at once to urge the merits of their respective machines. It was not so a half century ago. Then the city desiring to increase its pumping capacity by additional machinery, had to have plans prepared by its own officials or outside engineers, It was then a part of the duty of an efficient water-works superintendent to make designs for any new pumping engine which his works might require, and the more ponderous, complicated and novel his machine, the more was it relied on as a monument to his fame.

Gradually, however, the modern system of manufacturing has replaced the old contract machine shop. The firm which makes fifty pumping engines a year can make them far better and more cheaply than any general jobbing shop; and its corps of trained engineers can make designs for a better machine than any engineer could produce who is without experience in this branch of steam engineering. Thus it has come about that for nearly a score of years, with few exceptions, the design and construction of pumping machinery has been confined entirely to a few noted firms, which have vied with each other in the production of durable, low-priced and efficient machinery. In the matter of a high duty, however, it must be said that the yearly records made by a few engines designed by noted engineers, not by the old-time water-works superintendents, have not yet been equaled by any machinery which the best firms have been able to produce. For example we may cite the Corliss engine at Pawtucket, R. I., and the Leavitt engine at Lynn, Mass. The accompanying table gives the duty record of each engine made in its regular work in each year since erection. The first two columns give for each engine the duty attained in ft.-lbs. per 100 lbs. of coal used for all purposes, including starting and banking fires, pumping, and heating the building, with no deduction for ashes or cinders. The third column gives the duty record of the Corliss engine in ft.-lbs. per 100 lbs. of coal used for starting, pumping and banking, the coal used for heating being deducted, and the fourth column gives for the Leavitt engine the duty record per 100 lbs. of combustible used for all purposes including heating the building, the weight of ashes and cinders being deducted from the weight of the coal.

Yearly Duty Records of Pumping Engines at Lynn and Pawtucket.

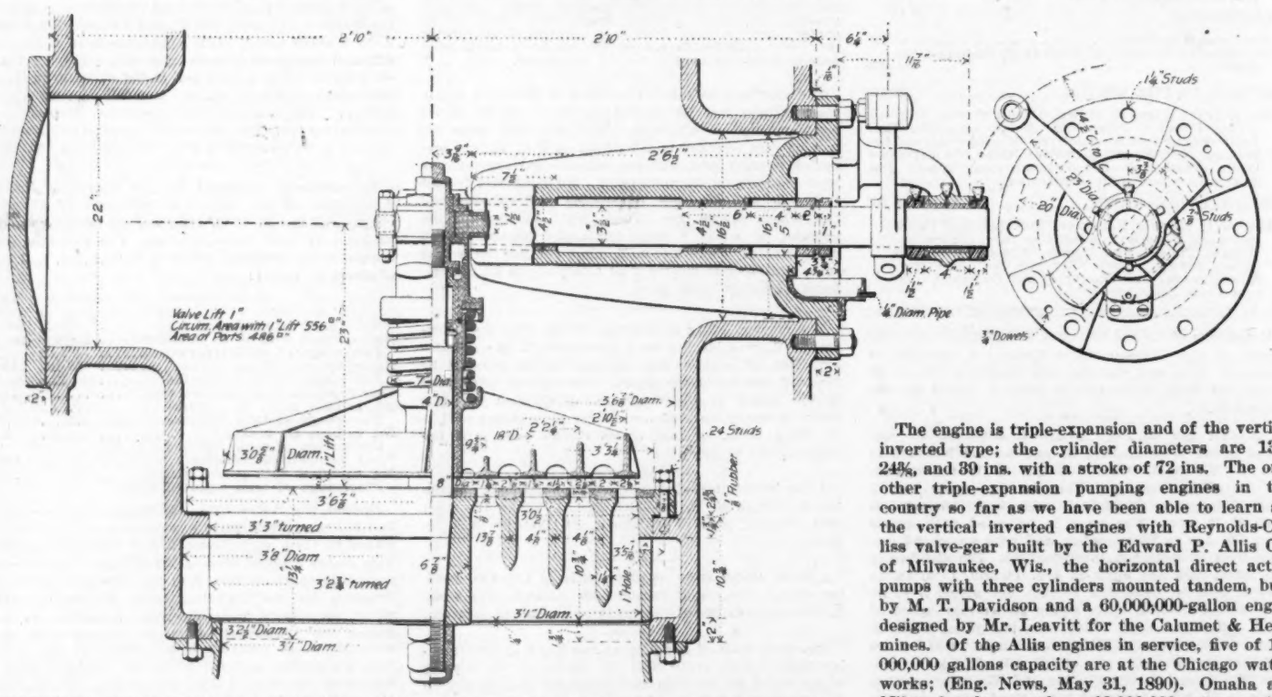
Year.	Duty in ft.-lbs. per 100 lbs. of coal burned for all purposes, including heating building. 1 = 1,000.		Duty of Corliss, deducting coal used for heating, but not deducting ashes. 1 = 1,000.	Duty of Leavitt, in ft. lbs. per 100 lbs. of combustible used for all purposes. 1 = 1,000.
	Corliss.	Leavitt.		
1875.....	.....	91,448	.....	101,167
1876.....	.....	89,862	.....	102,078
1877.....	.....	87,399	.....	98,074
1878.....	.....	90,137	.....	103,027
1879	.....	91,705	.....	105,015
1880.....	.....	92,843	.....	106 667
1881.....	103,948	91,568	106,481	105,939
1882	113,489	87,620	115.105	102,358
1883.....	106.204	.....	108,402	.....
1884.....	105,778	91,468	109,234	105,449
1885.....	108,124	98 606	110,489	110 309
1886.....	110,933	101,553	112,482	112,843
1887.....	120,169	102,060	121,417	113,556
1888.....	123,657	101,832	124,512	111,749
1889.....	98,124	107.124	104,257	119,060
1890.....	101,229	116,931	106,619	130,743
1891.....	101,206	102,863	106,709	113,886

Compared with the duties attained in contract tests, these records may not appear notable; but it must be remembered that a very large amount of fuel is used in banking and starting fires when engines are run only in the daytime. For example, the Leavitt engine in 1881 gave an average duty of only 91,468,000 ft.-lbs. per 100 lbs. of coal used for all purposes, but the average duty in the same year per 100 lbs. of coal used for pumping alone was 120,773,000, ft.-lbs. The fact that the Lynn engine has been in regular service for 19 years and the Pawtucket engine for 10 years will not escape notice as proof that these high duties are not attained at the expense of durability.

It might appear from the above table that the duty of the Leavitt engine had greatly increased with age; which, however, is not the case. The apparent low duty at first obtained was due to the small number of pumping days per year. Thus, in 1877 there were only 126 pumping days, and the coal used for starting and banking was 19.9% of the total; while in 1890 there were 289 pumping days, and the coal used for starting and banking was only 7.8%.

It is fair to point out, however, that sound business considerations may still justify the leading firms of pump builders in sticking to types of engines which give a somewhat lower duty but which are less complicated in construction and have a much smaller first cost. The majority of purchasers of pumping engines, either public or private, will not consider the extra cost of an engine of very high duty as simply an investment which is to yield an income through saving in the fuel bill. They will take the duty of an engine into account, indeed; but in the case of a private company hampered for cash, or a city whose Board of Aldermen contains a few cheese-paring members, a few dollars saved in first cost will outweigh a considerable number to be saved in the future. This, however, does not at all apply to such cities as Boston; and in the recent purchase of a great pumping engine to supply the high-service distribution from Chestnut Hill reservoir, the city officials determined to secure not only a high-duty engine, but one which should give the highest duty attainable. To this end Mr. E. D. Leavitt, M. Am. Soc. M. E., whose achievements on the pumping engines of Lynn and Lawrence are alone sufficient to place him in the front rank of pumping engine designers, was given a commission to prepare plans for a pumping engine of 20,000,000 gallons daily capacity.

A sectional elevation of the engine which has been designed by Mr. Leavitt, is illustrated on our inset sheet, and is such a novelty in pumping machinery that it deserves careful study.



ELEVATION AND SECTION OF PUMP VALVE MECHANISM, BOSTON HIGH-DUTY PUMPING ENGINE.

The engine is triple-expansion and of the vertical inverted type; the cylinder diameters are 13.7, 24¾, and 39 ins. with a stroke of 72 ins. The only other triple-expansion pumping engines in this country so far as we have been able to learn are the vertical inverted engines with Reynolds-Corliss valve-gear built by the Edward P. Allis Co., of Milwaukee, Wis., the horizontal direct acting pumps with three cylinders mounted tandem, built by M. T. Davidson and a 60,000,000-gallon engine designed by Mr. Leavitt for the Calumet & Hecla mines. Of the Allis engines in service, five of 15,000,000 gallons capacity are at the Chicago water-works; (Eng. News, May 31, 1890). Omaha and Milwaukee have each an 18,000,000-gallon engine; and there are two smaller engines at St. Paul and Brookline, Mass., the latter not yet completed. The Davidson pumps (Eng. News, March 12, 1892) are in service on the Brooklyn water-works, and are expected to give a duty under test of about 90,000,000 ft.-lbs.

What duty will be obtained from the Boston engine remains to be seen; but we believe a record as high as 140,000,000 ft.-lbs. is hoped for, which corresponds to about 1.4 lbs. of coal per HP. hour, or say 13% of the total energy in the fuel.

The following is a general description of the engine given in the specifications:

The engine cylinders are vertical and inverted; and are together with the valve gear, carried on an entablature, which is supported by six vertical columns and an equal number of diagonal columns; all columns springing from a heavy bed-plate.

The steam and exhaust valves are gridiron slides worked by cams on a horizontal shaft, which derives its motion by means of gearing from the crank shaft. The cut-offs of the intermediate and low-pressure engines

are fixed, but the high-pressure cut-off cam is advanced or retarded by the action of the governor, working through the agency of an hydraulic cylinder and a nut moving on a spiral part of the cam shaft.

Steam entering the high-pressure cylinder passes through a separator which forms the inlet side pipe. From this cylinder the steam passes through a tubular reheater on its way to the intermediate cylinder; and similarly through another reheater on its way from the intermediate to the low-pressure cylinder. The reheaters have steam of boiler pressure (185 lbs. per sq. in.) on the inside of the tubes, and the working steam on the outside. All the cylinders are steam jacketed, on heads and barrels, the high-pressure and intermediate cylinders being jacketed with steam of the boiler pressure, and the low-pressure cylinder with steam reduced to 100 lbs. pressure. Jackets and reheaters using steam of boiler pressure are drained back directly to the boilers. The low-pressure cylinder jacket and the working steam side of the reheaters are drained by automatic traps discharging into the feed-water heater.

The engine crossheads work on guides cast in the vertical columns. The motion is transmitted from the crossheads, by links, to beams or rockers carried in pedestals on engine bedplate. From these beams the connecting rods work off in one direction and the pump links in the opposite direction, but inclined at an angle of about 30° from the horizontal. The leverage of the various pins in the beams is such that the stroke, which is 6 ft. in the case of the steam pistons, is reduced to 4 ft. for the pump plungers; the double throw of the cranks being likewise 4 ft.

The crank shaft has three cranks at angles of 120°, the low-pressure crank leading, followed by the intermediate and high-pressure cranks. The shaft is carried in four adjustable four-box pedestals, the end cranks being overhung. Between two of the pedestals the shaft carries a fly-wheel, and between the other two the gear for driving the cam-shaft.

The pumps are seated on foundations on a lower level than those for the engines; the pump-chambers being tied to the engine bedplate by horizontal girders, as well as by the pump crosshead guides, which are inclined at 30° from the horizontal.

The pump bases, or suction chambers, six in number, one for each end of each pump, are connected together, and the bases of each pump are connected to a separate suction pipe. The lower or working pump-chambers are surrounded by annular spaces throughout their height, forming vacuum chambers. The upper pump-chambers contain the delivery nozzles, and above these are air-chambers, all six of the latter being connected by pipes.

Each end of each pump has one suction and one delivery valve, consisting of a number of rigidly connected rings covering annular openings in the valve seats.

The pump valves are operated as follows: The beam of each engine actuates, by means of links and rocker shafts, a wrist-plate on the pump of the next engine. From this wrist-plate motion is communicated to levers which close the four pump valves. After a valve is seated its lever still has a small motion which is taken up by a spiral spring through which the motion of the lever is imparted to the valve. When the lever rises it leaves the valve free to rise at the beginning of the next stroke.

The greater part of the water delivered by the pumps goes directly from the upper pump-chambers to the force main, but a portion of the water delivered by the high-pressure inboard pump is taken out by a separate pipe, and passes through the surface condenser. To compel the water to flow this way, a butterfly valve is fitted in the main delivery pipe of this pump, and by means of this and another butterfly valve in the pipe leaving the condenser, the amount of condensing water is regulated. The discharge pipe from the condenser joins the force main connection at a lower level.

There is a vertical single-acting lifting air pump situated directly below the condenser, and worked by an arm on one of the pump valve rocker shafts.

The normal speed of the engine will be 50 revs. per minute, at which speed the pumping capacity will be about 20,000,000 gallons per 24 hours. The pressure pumped against will be 55 lbs. per sq. in.

From the above description in connection with the vertical section of the engine and pumps shown on the inset sheet the general arrangement of the machine will be readily understood. The numerous departures from usual practice which have been made in its design are deserving of careful study.

The use of cams to operate the valves gives a quick cut-off and release, avoiding throttling in the ports. In the cam gear used by Mr. Leavitt in his mining engines the cut-off can be instantly varied between zero and 90% of the stroke, giving a full valve-opening for all cut-offs between 5% and 90%.

The use of gridiron valves to control the steam instead of piston valves, which are now rather popular, is for the purpose of preventing leakage and reducing clearance to a minimum. The clearances of the Boston engine are 3.1%, 3.8% and 5.2% for the high, intermediate and low pressure cylinders respectively. With piston valves the clearances would not be less than 10% in any cylinder and probably nearer 15%. The piston valve has the merit of perfect balance and consequent freedom from friction, which is an important matter with very high speeds and high steam pressures, but its use is inconsistent with the highest duty.

The gridiron valve has the further merit of uniform unbalanced pressure, so that the wear is equal all over the surface, and it has a very large area of bearing surface per unit area of port, so that the wear is small. Concerning the friction of the valve Mr. Asa M. Mattice, M. Am. Soc. M. E., Superintendent for Mr. Leavitt, writes us:

> With the Leavitt cam gear it is possible to regulate each function of the valve independently; so we close the exhaust to give a compression up to the initial pressure, and, as a consequence, the valve is in almost perfect balance at the instant of opening; the pressures on both sides being practically the same. In closing, the conditions are different from an ordinary slide valve, in that the gridiron valve has the same pressure on both sides, instead of one end and the middle covering ports with a smaller pressure below, as in the case of the slide valve. Then, again, as we so proportion the cylinders, receivers and the point of cut-off, under normal working conditions that the steam shall expand down to the receiver pressure without "drop," the exhaust valve is likewise balanced at the time of opening.

One of the best illustrations of the small friction of properly designed gridiron valves was afforded by the Lynn engine. In this engine the cam lets go of the valve after opening it, and does not touch it again until cut-off. When the engine was started it was found that the steam pressure (about 70 lbs. per sq. in.), acting on the area of the ⅞-in valve stem would close the valve (which was about 5 ins. × 13 ins.) as soon as the cam let go, unless the valve stem packing was set up hard. To remedy this, a "tail rod" was put on each valve extending through a stuffing box at the back of the valve chest, so as to put the valve stem in equilibrium. In some engines Mr. Leavitt has used a spring clamp on the valve stem to hold the valve stationary without using a tail rod, but in all his latter designs he uses a positive cam gear which holds the valve tightly in all positions. As to the use of the gridiron valve on high speed engines, I may cite the case of 17 Leavitt steam stamps at one plant, with cylinders 21½ × 24 ins., which make from 98 to 100 revs. per minute, 24 hours a day, and six days in the week.

The use of bevel gears with an intermediate shaft to drive the valve-gear arises naturally from the relative positions of the cam shaft and crankshaft. Wood mortise teeth of second-growth young hickory, cut to epicycloidal form are specified for the gear wheels on the upright shaft. Joints in valve gear are specified to be absolutely without lost motion, at the same time turning freely. All hardened steel pins must be ground on dead centers and all hardened steel bushings lapped out. Valve faces and seats are all finished by scraping and must be tested for tightness under steam of 185 lbs. pressure for the h. p. cylinder, 50 lbs. for the intermediate, and 5 lbs. for the l. p. cylinder. Valves, valve seats and cylinders are of cast iron, as hard as can be worked.

Connecting rods and links, engine crossheads, crank shaft and pump crosshead are all Krupp crucible steel forgings, oil tempered and annealed. The three engine beams are gun-iron castings. The specifications require steel forgings to be made of best open-hearth billets and without welds, except where otherwise specified. Steel castings are to be of open-hearth metal, and must show at least 60,000 lbs. tensile strength, with 15% elongation in test pieces 10 diameters, and not less than 7½ ins. long Phosphorus is limited to .06%.

Steam jacketing and reheating are very fully provided for, but as the boiler pressure is high (185 lbs.) the steam for the low-pressure jacket is taken through a reducing valve which lowers the pressure to 100 lbs. The method of condensing adopted is substantially the same as that used by Mr. John W. Hill, of Cincinnati. A part of the water sent into the force main is directed through the condenser, from which it is returned to the force main again. Condensation is thus secured with no expense for circulating pumps and no loss of the condensing water.

Perhaps the feature of the engine's design which will be most generally criticised is the location of the pumps to one side of the engine, which makes it necessary to drive them by a rocking beam connection. Of course this throws a heavy load on the axis of these beams and a considerable amount of power is expended in friction.

This peculiar arrangement was made necessary by existing conditions. The engine had to be built to suit the height of the engine-house, the foundations of adjoining engines and position of pump well. The arrangement would have been quite different if these limiting conditions had not existed, and the cost would have been very much less.

With the present arrangement, however, there are some compensating advantages.

The pumps located to one side of the engine and on separate foundations are much easier of erection, inspection and maintenance than they would be if located directly beneath the steam cylinders. Further, the method of driving the pumps allows them to be run at a lower piston speed than the engine and thus permits a higher speed for the engine. At the specified speed of 50 revs. per minute this engine will have a piston speed of 600 ft. per minute, with a speed of the pump plungers of 400 ft. per minute, which is an astonishing rate for a pumping engine. For example, Mr. Leavitt's Lawrence engine has a speed of only 256 ft., the Corliss engine at Pawtucket runs at about 250 ft. and the Davidson direct-acting, triple-expansion pumps, at Brooklyn, have 179 ft. piston travel per minute. The advantages of high piston speed in the economical use of steam are well recognized.

The very high speed adopted for this engine, however, is made possible chiefly by the use of the Riedler positive valve gear for the pump valves. This is, we believe, the first pumping engine built in this country which is fitted with positive moved valves,* and as the advantages of such valves on pumps, blowing engines, etc. are not always clearly understood, an explanation may be of interest.

In all types of reciprocating pumps fitted with valves moved by the flow of the water, there is necessarily a certain backward flow at the end of each stroke which causes the valves to seat. This flow is then suddenly arrested and the result is a water hammer which it is the object of all designers of pumps to reduce to a minimum. The old-fashioned pumps with large metal valves had to run at very low speed and make a pause at the end of each stroke to allow the valves to seat. Modern practice has substituted a great number of small, rubber or leather valves of very low lift for the heavy metal valves and has thus made possible a great increase in speed. But the improvement has only reduced the difficulty, not remedied it. The back flow and water hammer still exist, though in very small amount, and make the speed of the pump plungers far less than that which is feasible with the steam cylinders.

With the Riedler valve gear a more radical remedy than that above described is applied. At the instant the stroke ceases, the valve is firmly closed before the moving water has an opportunity to begin a backward flow. Water hammer is thus entirely obviated, and the great obstacle to high speed and corresponding high efficiency is removed.

Besides this principal advantage the loss in efficiency due to the backward flow through the ports during the closing of the valve is wholly obviated. The accompanying motion diagram shows the action of one of the suction valves and its operating gear during one revolution of the engine. It will be seen that the lift of the valve is practically instantaneous, and the water flows through the full opening. This is a manifest advantage over weighted or spring valves, which put an extra load on the engine by the resistance which they offer to the flow. While the closing of the valve is positive, at no time is the flow through the ports throttled, for the valve approaches its

* We learn that the late Geo. H. Corliss built a pumping engine with controlled valves, about twelve years ago. It was not a great success, however, and the controlling gear was soon removed.

seat no faster than the volume flowing through the ports is lessened by the slowing of the plunger toward the end of its stroke. Another interesting detail which should be noticed is that a steel spring held under an initial tension is placed above the valve and below the sleeve which operates it. In case an obstruction should be on the valve seat, this spring will yield and prevent injury to the mechanism.

The fact that the motion of the valve closing gear is taken from a point 120° in advance of the crank also makes the spring necessary, since the closing gear must have some motion after the valve is seated, and with the arrangement adopted this simply compresses the spring about ⅛ in. The spring is made long enough, however, to permit this compression even with an obstruction on the valve seat.

Besides the valve mechanism other details of the pumps are worth careful study. The shape of the ends of the plungers attracts attention at once. The purpose is obviously to diminish eddy currents about the piston and prevent the water from breaking away from the end of the plunger on the suction side, which sometimes occurs with high speed pumps. The very large volume of the suction and discharge chambers, which seem to one accustomed to ordinary practice, quite out of proportion, is well justified by the slow and easy movement of the water through them which is thus secured. To fill the suction chambers on starting the pump a 1½-in. pipe is tapped into each vacuum chamber and leads to a 3-in. pipe terminating in a 3-in. steam ejector. To start the pumps this ejector is first operated. The air is thus exhausted from the vacuum chambers and the water rises from the suction main and fills the vacuum and suction chambers up to the ejector pipe level. A by-pass from the force main is then opened, completing the filling of the suction chamber. The ejector is also used to regulate the height of water in the vacuum chamber.

The specifications for material and workmanship are very full and require throughout the best obtainable. Proposals for constructing the engine were opened May 12, 1892, and were as follows:

Holly Manufacturing Co., Lockport, N. Y.	$153,000
I. P. Morris & Co., Philadelphia	144,239
Geo. F. Blake Mfg. Co., Boston	133,000
N. F. Palmer & Co., New York City	124,000

The contract was awarded to the lowest bidder, after some changes had been made in the design of the engine, simplifying and reducing the cost, at $120,500, and work is now well advanced on the engine at the Quintard Iron Works, 742 East 12th St.

As the city furnishes foundations, steel forgings, engine beams and babbit metal, and also bears the total cost of engineering including the preparation of over 120 sheets of detailed working drawing, the total cost of the engine to the city will probably reach $145,000.

In our editorial columns we have discussed at length the relative economy of the engine compared with the high-duty engines made by the leading builders of pumping engines.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 545.)

Long Branch, N. J.

Long Branch is a well known seaside summer resort. The population of the town in 1890 was 7,231, against 3,833 in 1880. A public water supply was introduced in 1877 by the Long Branch Water Supply Co. A sewerage system was put in operation in 1886 by the Long Branch Sewer Co., under a franchise granted by the town which provided that no objectionable matter should be discharged into the adjacent water. In order to discharge sewage into the ocean at the beach a system of mechanical separation aided by chemical precipitation was adopted, as described below.

On Dec. 1, 1892, there were in use about ten miles of sewers, over 400 connections, 118 manholes, all ventilated by 12 1-in. circular holes in the covers and provided with buckets below to catch the dirt from the dirt roads of the town. There are no flush tanks.

At dead ends the company has until recently connected rain water leaders to the sewers free of charge, but in the future a charge equal to one half the charge for an ordinary service connection will be made. In all about 100 rain water leaders have been connected with the sewers, those not on dead ends bringing in the revenue just mentioned. In this connection it may be added that the company's franchise provides that the yearly rental for sewer connections shall be two mills on the dollar on the assessed valuation of the property. Recently the town authorities passed an ordinance relating to houses occupied by more than one tenant, which provides that the yearly charge may increase directly with the number of tenants.

Aside from the rain water admitted to the sewers the separate system is used.

The sewage is all brought to a station located on Long Branch Ave., near Second Ave. The station is surrounded on all sides by shops and dwellings. A by-pass is provided to permit the sewage to be passed around the station, directly to the tidal chamber and ocean. During heavy rains in the winter season no attempt at purification is made, the sewage passing directly into the ocean. At all other times, it is stated, the sewage is treated.

The arrangement and operation of the purification works is shown by Figs. 50 to 53. As will be seen by the plan, Fig. 50, there are two receiving tanks, duplicates. These are constructed of concrete and are used alternately. Alum is admitted to the sewage before it enters the tanks. The sewage then passes beneath planks on edge, over walls, through submerged arches and finally over a wall to and through coke filters placed vertically, the flow being continuous. The coke is confined in removable wire cages 5 ft. deep and 1 ft. wide and the sewage passes through two of these, or horizontally through 2 ft. of coke. The coke is renewed once a year. Doubtless it was originally intended that the coke should be renewed oftener. Its only purpose is to serve as a strainer. The coke for each renewal costs about $2.

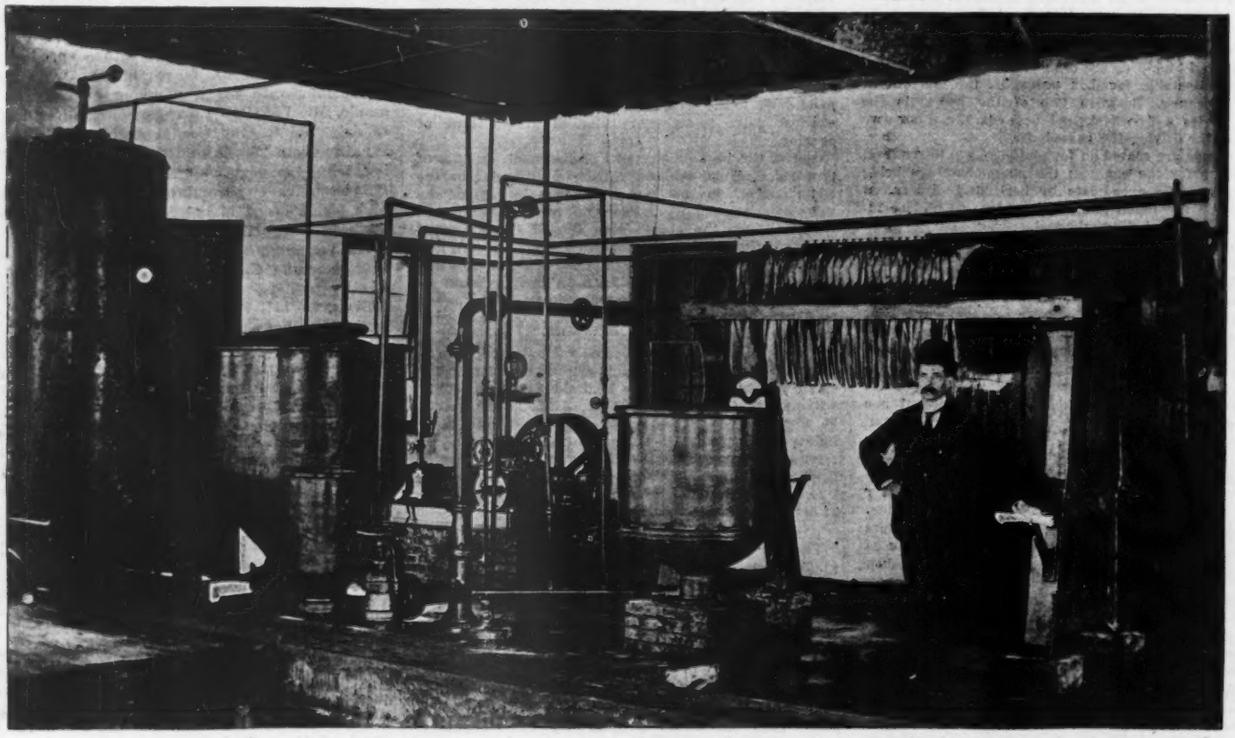


FIG. 52. VIEW OF INTERIOR OF SEWAGE PURIFICATION WORKS AT LONG BRANCH, N. J.; Carrol Ph. Bassett, M. Am. Soc. C. E., Engineer.

About 75 lbs. of alum per day, mixed with water in a 500-gallon tank, are used. It is said that about this amount has been used daily since the works were put in operation. The alum costs about 1½ cts. per pound, with freight from New York in addition.

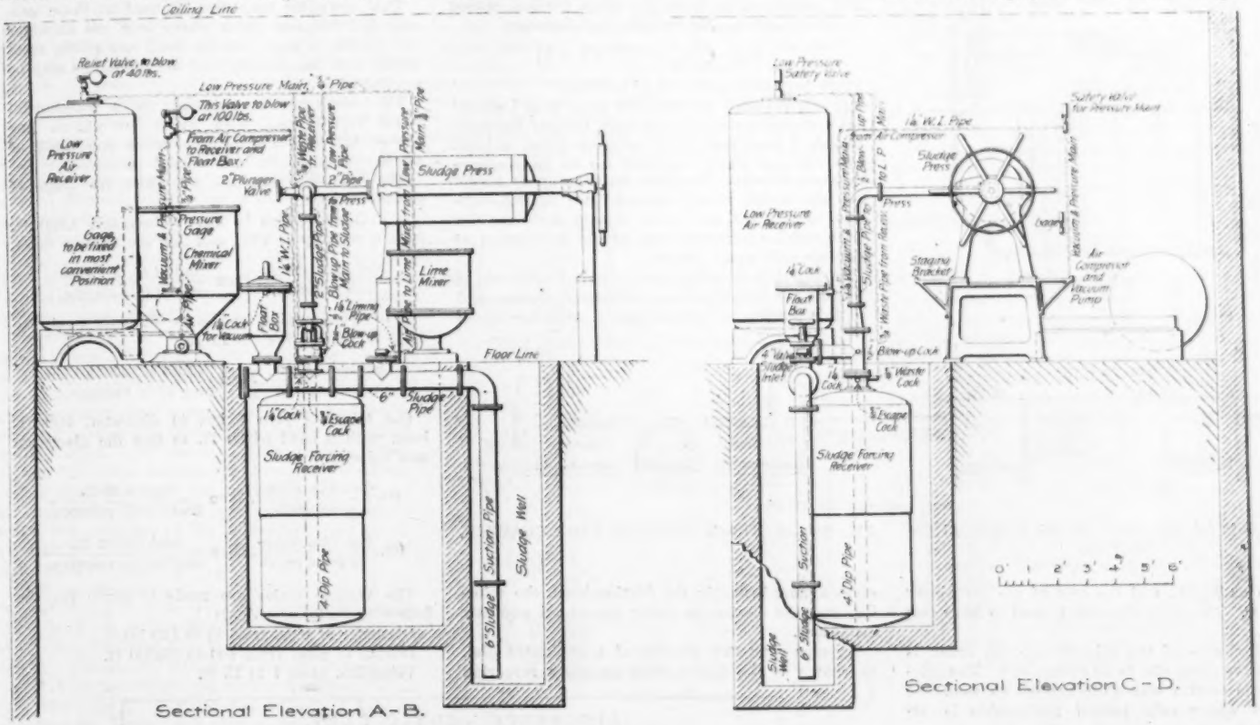
Lime is used for treating the sludge only. The lime and alum mixers are shown in Fig. 50. "Sanitas" is used as a disinfectant about the station.

The sludge is removed by means of the apparatus shown in plan and section in Fig. 51. Fig. 52 is a photograph of the same apparatus which also shows the alum mixer. This apparatus includes an air compressor and vacuum pump, a low pressure air receiver, sludge receiver and Johnson

filter press for pressing the sludge into solid cakes. In operation the air is exhausted from the sludge receiver, after which the valve in the pipe leading to the bottom of the sludge pit is opened and the sludge passes into the receiver. A float at the left indicates when the receiver is full. Lime is admitted to the sludge just before it enters the receiver. With the aid of the compressed air the sludge is forced from the sludge receiver into the cells of the filter press and there by the action of the compressed air the liquid is pressed out and the solid matter compacted into cakes.

At Long Branch the sludge is dropped from the filter press into the sludge car, without an effort to remove the cakes intact. The press has a capacity of 24 cakes but only 20 cells are now in use. A full press is said to contain about 21 cu. ft. of sludge. The sludge is given to one of the directors of the company and used on his farm. In summer the sludge is said to be removed once in three or four weeks. The officers of the company state that during the remainder of the year it is difficult to get enough sludge to show visitors the working of the sludge apparatus.

The small amount of sludge, the officials state, is explained by the fact that many sewer connections are made with cesspools, which retain solid matter.



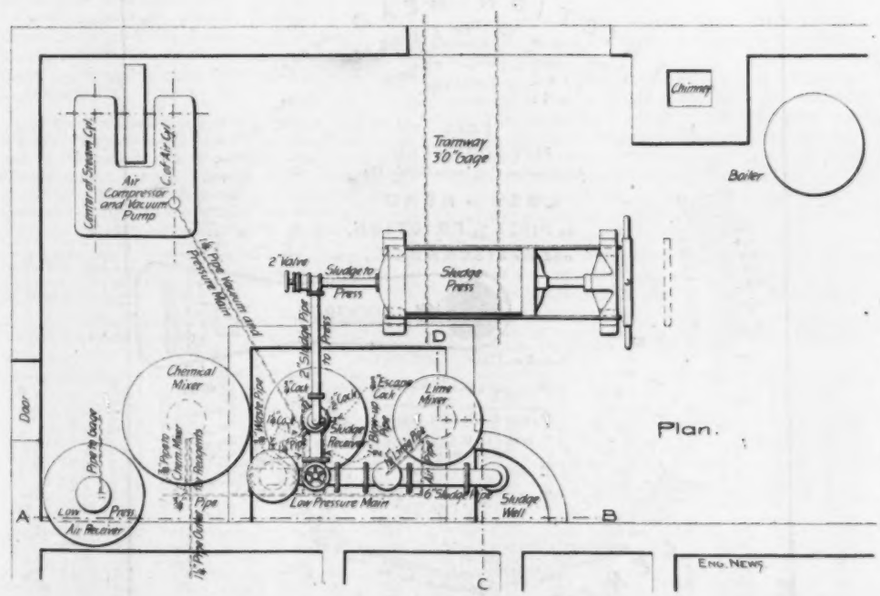


FIG 51.—PLAN AND SECTIONS SHOWING SLUDGE COMPRESSING APPARATUS.

The sewage tanks were originally covered and were ventilated to a small furnace at the side of the boiler chimney, where tar was burned. The officials state that the perforated manhole covers afford all necessary ventilation. Therefore the tank covers have been removed and the ventilating furnace is not used. The effluent is pumped by a 6-in. Weber centrifugal pump, said to have a capacity of 600 gallons per minute. The pump is driven by a 20-HP. Westinghouse engine. The pump, engine and boiler were furnished by the Westinghouse Machine Co. All the other machinery was furnished by S. H. Johnson & Co., Stratford, England. No pumping records are kept and the amount of sewage treated is unknown.

The cost of operating the purification plant could not be obtained from the company, but it was found that one man is constantly employed at the station and that for four months in the year an assistant is employed. In addition a helper is occasionally employed. At 75 lbs. per day the total amount of alum used in the year would be a little over 27,000 lbs., provided it was used every day. But during heavy rains the sewage is not treated. Probably not more than 25,000 lbs. of alum is used in a year, the price in New York, as given above, being about 1½ cts. per lb.

The expense for lime and disinfectants must be light. Coal cannot be a great item, for the lift of sewage by the pump is small and the air compressor and vacuum pump is not often used. The officers of the company, with the exception of the secretary, do not have a salary. A 4% dividend has been declared recently.

The station is something over 2,000 ft. from the point where the effluent is discharged into the ocean. The effluent first passes through 1,200 ft. of 24-in. vitrified pipe which ends in a masonry chamber beneath the street, 400 ft. long, 8 ft. wide and with an average height of between 3 and 4 ft. A longitudinal and transverse section of this chamber is shown by Fig. 53. There is a manhole at each end and at the lower end there is a gate, operated by a rack and pinion, to control the outlet pipe. This chamber was designed to serve as a tidal chamber to allow sewage to be stored for discharge at ebb tide. The officials of the company state that quicksand was encountered in the construction of the chamber which prevented its being carried to the full proposed depth. Its capacity is only about 75,000 gallons and no use is made of it, purified sewage flowing through it constantly to the sea.

The engineer of the sewerage system, Mr. C. P. Bassett, M. Am. Soc. C. E., states regarding the construction of the tidal chamber that "the original intention was never carried out by the company because of the expense, which was felt to be unnecessary."

In preparing the illustrations for this article, since the above was written it was found that the drawings at hand did not agree as to the dimensions of the cross section of the tidal chamber. The cross section given agrees with that mentioned in the article below. The facts in the case could not be obtained in time for this issue.

From the chamber 200 ft. of 24-in. vitrified pipe extends to the beach and some 250 ft. of 16-in. wrought iron pipe across the beach and out into the sea. This wrought iron pipe is now protected by a jetty of piles driven 25 ft. deep. The pipe at the outlet turns down with an elbow 4 ft. long.

The cost of the lot and building used as a station

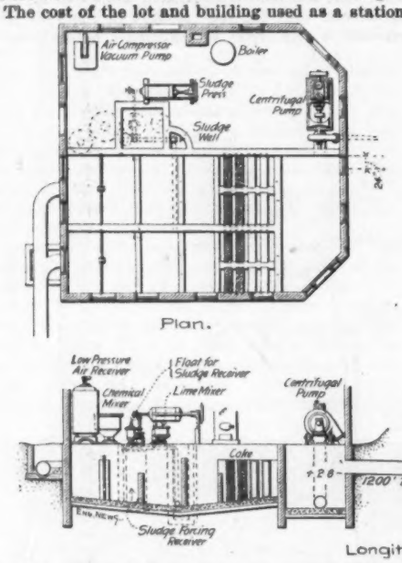


FIG. 50.—PLAN AND SECTION OF PURIFICATION WORKS.

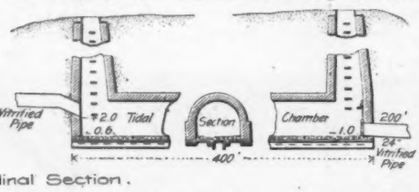


FIG. 53.—SECTIONS THROUGH TIDAL CHAMBER.

is given as $8,000, and the cost of the machinery as $5,000. The tidal chamber is said to have cost $20,000.

The discharge of the effluent into the ocean is said to have given rise to no complaints. The effluent at the station was quite cloudy, as would be expected where only partial purification is attempted.

The writer visited the plant on Dec. 1 and obtained from the officials most of the information given. The balance of the information has been taken from a short description of the purification plant, prepared by the engineer, Mr. C. P. Bassett, M. Am. Soc. C. E., and published in the report of the New Jersey State Board of Health for 1887. Mr. Bassett also furnished the matter for the illustrations. The officers of the company are as follows: Secretary, Wm. R. Warwick, Jr.; Superintendent of Construction, R. C. Adamson; Treasurer, R. V. Breece; President, Chas. P. McFaddin; Vice-President, Wm. W. Conover.

PIPE COMPUTATIONS.

By William Cox.

Having had frequent occasion to use Weisbach's formula

$$H = \left(0.0144 + \frac{0.01716}{\sqrt{V}}\right) \frac{L\,V^2}{5.367\,D}$$

to obtain the friction head in pipes discharging water with various velocities, I discovered another one which, for all ordinary velocities, say 1 to 15 ft. per second, gives almost identical results, and is very much simpler to work out.

My formula is

$$H = \frac{L}{1{,}200\,D}\left(4\,V^2 + 5\,V - 2\right)$$

in which

L = Length of pipe in feet,
D = Diameter of pipe in inches,
V = Velocity in feet per second, and
H = Friction Head in feet.

I have further simplified this by reducing it to the form

$$H = \frac{L \times C}{D}$$

in which C is a variable, being replaced by the following values, according to the velocity:

Velocity of 1 ft.,	C = 0.00583	Velocity of 6 ft.,	C = 0.1433
" 2 "	= 0.02	" 7 "	= 0.19083
" 3 "	= 0.04083	" 8 "	= 0.245
" 4 "	= 0.06833	" 9 "	= 0.30583
" 5 "	= 0.1025	" 10 "	= 0.3733

Example.—Find the loss of head by friction for 400 ft. of 12-in. pipe, the velocity being 3 ft. per second.

$$H = \frac{400 \times 0.04083}{12} = 1.361 \text{ ft.},$$

which is practically the same as the result obtained by Weisbach's formula.

Wiesbach's formula is also sometimes used with 20% added on, to cover the extra friction caused by riveted pipes. My formula then becomes

$$H = \frac{L}{1{,}000\,D}\left(4\,V^2 + 5\,V - 2\right)$$

which is exceedingly easy of solution.

It will probably be urged by some that I should have adopted some other formula, notably Kutter's. To this I must reply that the work I had in hand was not one which required me to discriminate between different formulae, but merely to accept the one which was in general use among engineers having to deal with certain problems for given definite purposes, such as the installation of turbines and water wheels.

Having thus simplified the formula I next sought to make the computation a mechanical process, and for this purpose at length made a computer which gives almost instantly the friction head, the velocity, and the discharge, under almost all and any conditions.

My pipe computer consists of a graduated dial, as shown in the figure, with an inner revolving graduated disk, the various scales of which correspond to the different factors H. L. D. V. and C. the latter being eliminated by the position of the scales. To effect a computation, all that is required is to turn the dial round and thus to set opposite each other the diameter and the length of the pipe, when the friction head will be at once found opposite the velocity.

This computer may also be used in those general and frequent cases where only the diameter and length of pipe and the head are given, from which both the velocity and the discharge may be obtained.

The computer is mounted on a substantial board 12 × 12 ins., with brass swivel. It has proved that it will solve problems in one-eighth of the time required by the ordinary methods.

The following examples will show the scope of the instrument:

(1.) Given a pipe 12 ins. in diameter, 4,100 ft. long, a velocity of 3 ft., and find the friction head.

$$\frac{\text{Set 12-in. diam.}}{\text{over 4,100 ft.}}, \text{ then } \frac{\text{find 14 ft. f. head}}{\text{over 3 ft. velocity.}}$$

(2.) Given a pipe 10 ins. in diameter, a velocity of 13 ft., to find the discharge.

$$\frac{\text{Set 10-in. diam.}}{\text{to gage point}}, \text{ then } \frac{\text{find 425 cu. ft.}}{\text{over 13 ft. velocity.}}$$

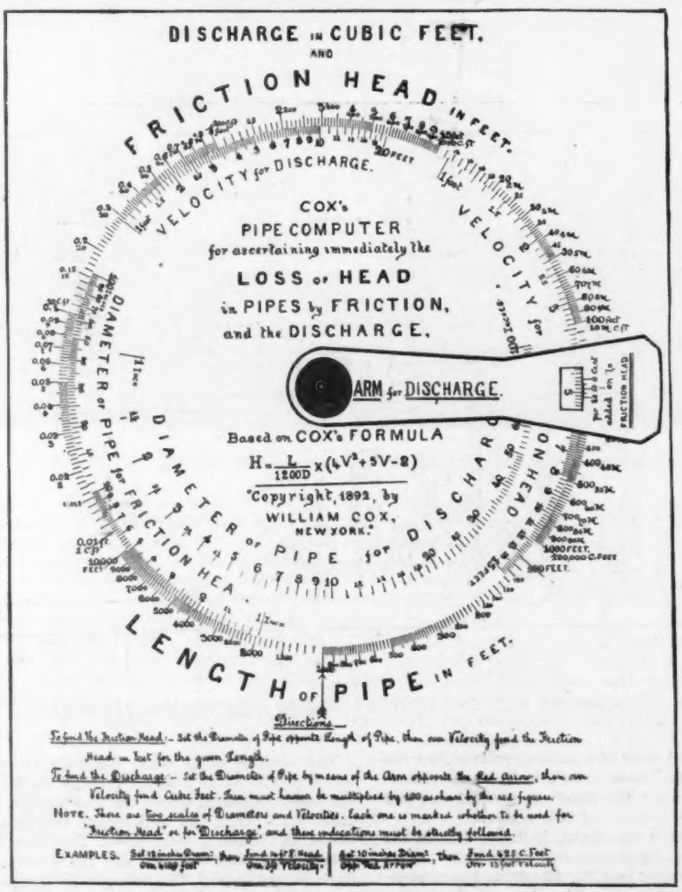
(3.) Given a pipe 8 ins. in diameter, 900 ft. long, with a head of 30 ft. to find the discharge and velocity.

(a). $\frac{\text{Set 8 in. diam.}}{\text{over 900 ft.}}$, then $\frac{\text{under 30 ft.}}{\text{find 8.4 ft. velocity.}}$

(b). $\frac{\text{Set 8-in. diam.}}{\text{to gage point}}$, then $\frac{\text{find 175 cu. ft.}}{\text{over 8.4 ft. velocity.}}$

The various scales are made to serve for the following limits of values:

Diameter of pipe, from ½ to 100 ins.
Length of pipe, from 100 to 10,000 ft.
Velocities, from 1 to 15 ft.


DISCHARGE IN CUBIC FEET.
AND
FRICTION HEAD IN FEET.
VELOCITY for DISCHARGE.
COX's
PIPE COMPUTER
for ascertaining immediately the
LOSS of HEAD
in PIPES by FRICTION,
and the DISCHARGE.
ARM for DISCHARGE.
Based on COX's FORMULA
H = L/1200D x (4V²+5V-2)
Copyright, 1892, by
WILLIAM COX,
NEW YORK.
DIAMETER of PIPE for FRICTION HEAD
LENGTH of PIPE IN FEET.
Directions—
To find the Friction Head.—Set the Diameter of Pipe opposite Length of Pipe, then run Velocity found the Friction Head on last for the given Length.
To find the Discharge.—Set the Diameter of Pipe by means of the Arm opposite the Red Arrow, then run Velocity found. Cubic Feet. Then must known be multiplied by 100 as shown by the red figures.
NOTE. There are two scales of Diameters and Velocities. Each one is marked whether to be used for "Friction Head" or for "Discharge," and these indications must be strictly followed.
EXAMPLES.

THE COX PIPE COMPUTER.

(About one third actual size.)

Friction head, from 0.01 to 1,000 ft.
Discharge, from 1 to 100,000 cu. ft.

From these limits it will be seen that the instrument is comprehensive enough for all practical purposes.

THE EFFECT OF CUSHIONING CEMENT GRIPS.

Probably the most annoying difficulty with which the engineer has to deal in the testing of cements for tensile strength, is the breaking of the briquettes through the head instead of at the smallest cross-section. This irregular fracture can in most cases be justly attributed to the form of the jaws of the grip, supposing proper care to have been taken to properly adjust the briquette in the grip. The type of grip recommended by the American Society of Civil Engineers holds the briquette at a single point and in hard specimens the chiseling action is sufficient to cause imperfect fractures. To remedy this engineers often slightly flatten the jaws of the grip or place strips of cardboard, blotting paper, rubber, etc. between them and the briquette to equalize the pressure and increase the surface of contact, with more or less success. A peculiar form of grip in which the bearing surface is a tube of rubber slipped over a steel pin, was illustrated in our issue of Dec. 20, 1890. With this grip unusually good results have been obtained in securing perfect fractures. The results of cement tests in which some elastic material has been used between the grips and the briquettes are, however, widely scattered and not easily obtainable. As far as known they have been sufficiently good to make the question of the advantage and disadvantage of introducing a compressible bearing well worth attention.

In a recent report of a sub-committee* of the commission of French government engineers upon "The Methods of Testing Materials of Construction" this question has been taken up at some length. The report quotes briefly the results arrived at by the committee of the Am. Soc. C. E. and those given in Vols. XXIV. and XXV. of Engineering News, and states that no similar experiments with compressible bearings had been before that time made with the type of grip and briquette commonly used in Europe, which are shown in Fig. 1. It states that with this grip and briquette irregular fractures appear to be much less frequent than with the American types and says:

> This result is doubtless due both to the form of the briquette, which is molded with a groove at the center, and to the form of the grip, which, instead of being sharply convex and thus affording only a small surface of contact, has a large radius of curvature at the point of contact. This decreases considerably the tendency to cut the briquette, shown by the American grip, since an increased pull simply increases the surface of contact. In addition, the respective forms of the briquette and grip at the point of contact, as well as the manner of suspending the grip, have been designed to diminish as much as possible the probability of unsymmetrical fracture. Irregular fractures are quite liable to be produced in old briquettes of neat cement. This is shown by a study of the briquettes at at the Bologne laboratory broken outside of the central groove. If these are divided in two classes, (1), neat cement briquettes of over three months' age, and, (2), all other briquettes, both of neat cement and cement and sand mortar, the number of irregular breakages in the first class is 15 per 100, and in the second class, 3 per 100. The breaking strain is always practically the same whatever the irregularity of the fractures and consequently their areas. Often in old briquettes of neat cement, and particularly in cements of certain classes, these fractures occur in the middle of the head; generally the upper head. The more common types of such fractures are shown by the lines a, b, c and d in Fig. 1.

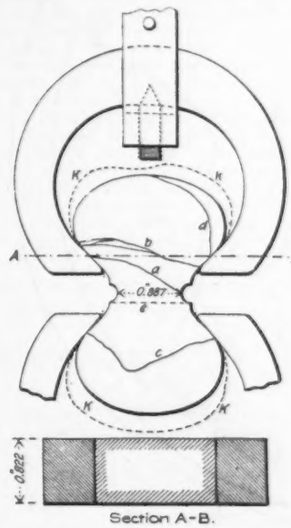


Fig. 1. Grip and Briquette used in Making Cement Tests in France.

To test the effect of the introduction of a compressible material between the jaws of the grip and the briquette, a series of 80 briquettes was broken, taking 20 briquettes each with naked grips, and with bearings of rubber, cardboard and lead. In the manufacture of these briquettes a class of cement was used which was especially liable to irregular fractures. The briquettes had been immersed about a month. The strips of rubber, cardboard and lead were equal in width to the thickness of the briquette and were arranged as indicated by the line K in Fig. 1. The eccentricity of the fracture was determined by comparing the weights of the two fragments of the briquette. Taking the weight of the whole briquette at 200 the eccentricity was denoted by the variation from 100 of the upper half-briquette; and all briquettes were considered broken outside of the groove which showed an eccentricity equal or greater than 5.5, a value corresponding to the line e, Fig. 1. The results of this series of tests are given in Table I.

It will be seen from these figures that the use of cardboard has not practically benefited the results, but that the lead and especially the rubber have reduced the eccentricity of the fracture, without increasing much the regularity of the unit strength. The accompanying table shows more in detail the location of the fractures under the several conditions of the tests:

	Unprotected.	Rubber.	Cardboard.	Lead.
No. fractures outside groove...	5	1	6	3
" " above center.....	7	12	5	12
" " at "	1	0	0	2
" " below "	12	8	15	6
" resistances greater than mean.....	25	23	20	20
" resistances less than mean.	15	17	20	20

To test still further the effect of rubber bands upon the regularity of fracture 30 briquettes which which had been immersed in sea water for 5½ years, and which, it was thought, would be especially liable to irregular fracture, were tested. The summaries of the results obtained were as follows:

	Unprotected.	Rubber.
Mean ultimate strength of 15 briquettes, kilos	48.82	51.93
Mean error	±9.04	±7.95
Number of irregular fractures	2	3

In regard to the results of the tests as a whole the committee considers that the use of rubber bearing tends to regulate the position of fracture and the ultimate strength, but that so much inconvenience is connected with its use that it does not seem worth while to change the design of testing apparatus now in common use, in order to adopt it.

* Rapport sur L'Interposition de Corps Compressibles entre les Griffes et les Briquettes dans les Essais de Cements a la Traction, Presente par M. Feret au nom du Sous-Comite.

TABLE I.—Showing Comparative Regularity and Strength of Fracture of Neat Cement Briquettes Broken with Jaw of Grip Unprotected and Covered with Rubber, Cardboard or Lead.

Unprotected.				Rubber.				Cardboard.				Lead.			
Eccentricity of fracture.	Sectional area of fracture, sq. in.	Resistance per sq. in. of minimum section, lbs.	Resistance per sq. in. of section of rupture, lbs.	Eccentricity of fracture.	Sectional area of fracture, sq. in.	Resistance per sq. in. of minimum section, lbs.	Resistance per sq. in. of section of fracture, lbs.	Eccentricity of fracture.	Sectional area of fracture, sq. in.	Resistance per sq. in. of minimum section, lbs.	Resistance per sq. in. of section of fracture, lbs.	Eccentricity of fracture, sq. in.	Sectional area of fracture, sq. in.	Resistance per sq. in. of minimum section, lbs.	Resistance per sq. in. of section of fracture, lbs.
+ (7.5)	0 937	426	342	— (6.0	0 850	496	455	+ 2.0	0.821	383	362	— 3.0	0.789	404	394
+ 0.5	0.796	398	386	+ 1.5	0.791	461	448	+ 3.5	0.821	476	434	— 1 5	0.806	412	408
— 5.0	0.887	461	412	— 2.0	0.806	489	470	— (6.5)	0.865	55	406	— 2.0	0.815	497	473
— 0 5	0 875	483	418	+ 1.0	0.730	489	477	+ (6.5)	0.919	504	481	+ 1.5	0.810	461	441
+ 3 0	0.875	475	452	— 1.5	0.797	504	488	+ 2.5	0.785	369	393	— (6.5)	0.883	483	424
+ 1.5	0.785	447	441	+ 2.5	0.830	496	464	+ 3.0	0.853	489	446	— 3.5	0.769	458	427
— 1.0	0.800	412	382	— 3.0	0.830	518	483	— 1.5	0.874	539	519	+ 1.0	0.813	504	480
0	0.792	291	283	+ 1.0	0 789	447	439	+ 5.0	0.867	518	482	0	0.785	475	418
+ 4.5	0.836	511	414	— 1.5	0 781	496	483	+ 1.5	0.800	432	420	— 4.0	0.827	461	432
+ (5.5)	0.883	418	412	+ 3 5	0.875	518	493	+ (6.0)	0.920	504	430	+ 1.5	0.804	455	438
+ 4.0	0.875	511	448	— 0.5	0.792	455	441	— (6.5)	0.840	447	412	— 1.5	0.821	440	416
+ 1.0	0.789	331	328	+ 1.0	0.790	440	431	+ 1.5	0.794	412	402	+ 1.5	0.775	4 4	404
— 5.0	0.852	475	433	— 3 5	0.857	496	461	— 4.0	0.837	398	369	— (8.0)	0.868	383	342
— (6.0	0.867	426	390	— 3.0	0.799	454	392	— (6.0	0.867	483	431	0	0.797	426	413
— 1.5	0.830	392	375	+ 1 0	0.815	419	398	+ 1.0	0.805	447	431	— 2.0	0.785	398	391
+ (8.0)	0.792	489	426	— 2.0	0.797	447	432	+ (6.0)	0.867	383	317	— 2.5	0.797	472	420
+ 1.5	0.795	454	441	— 1.5	0.822	383	452	+ 1.5	0.837	419	3 7	+ 1.0	0.804	455	438
+ 2.5	0.813	418	447	— 1.5	0.797	475	461	+ 2.5	0.831	412	83	— 2.0	0.797	512	399
— (6.0	0 824	496	467	+ 3.5	0.831	475	444	+ 1.5	0.780	432	425	— (6.5)	0.867	426	381
+ 2.5	0.813	432	414	— 1.5	0.761	390	398	+ 0.5	0.736	4 4	426	+ 4.0	0.851	376	342
.....	....	401	373	.....	.....	427	452	... ..	...	450	419	.....	.....	437	419

* In computing this area the air bubbles have been taken into account.
** The minimum section is exactly 0 775 sq. in.

A magnesium flashlight for light-houses is being tested for the U. S. Light-House Board by Maj. D. P. Heap, in charge of the Staten Island station. The apparatus is devised by Prof. C. C. Schirm, of Berlin, and without the assistance of lenses or prisms, it is rated as equivalent to from 200,000 to 300,000 candle-power. The apparatus consists essentially of a benzine-tank through which atmospheric air is drawn by a bellows and charged with gas; a vessel containing magnesium powder and pumice-stone; clockwork for operating it, and a two-burner benzine lamp. A certain quantity of the magnesium powder falls at regular intervals is taken up by the jet of gas-loaded air, and is ejected from a wide tube and there ignited by passing over the flames of the lamp. The sudden flash thus produced has red rays in it, and can be seen for more than 8 miles on a clear night.

The sixth annual report of the Interstate Commerce Commission, just presented to Congress, gives much space to an explanation of the effect of recent decisions of the United States courts upon the Commission's powers. While the recent decision of Judge Gresham, refusing to compel witnesses to testify before the Commission will inevitably hamper the Commission in conducting the investigations which are its legal duty, it by no means leaves the law invalid or the Commission powerless to enforce it. The numerous court decisions sustaining and enforcing the Commission's orders have received little attention from the public; yet these decisions have been numerous and important during the past year.

Much interest has been aroused by the circular inquiry sent out by the Commission, asking opinions as to the advisability of repealing or modifying the clause of the law which prohibits pooling. The replies received show that there has been a considerable change of opinion during the past five years, and that many would now favor the legalization of such contracts between competing lines as would tend to diminish discrimination in rates, and the better maintenance of lawfully authorized, reasonable rates. The Commission, however, says that it is much more important to protect the public from discrimination and extortion on the part of the railways than to protect the railways from each other. The Commission has repeatedly urged upon Congress various amendments to the law intended to facilitate its enforcement. Until these measures for the more effective protection of the public are taken, the Commission will oppose any modifications of the anti-pooling clause.

MASONRY DAM OF THE BUTTE CITY WATER CO.

In our last issue we described and illustrated a dam now being built by the Butte City Water Co. at Butte, Mont. The accompanying cut, Fig. 5, omitted last week, shows the details of the valve cover and seat used on the vertical or upturned ends of the intake pipes. The cover is raised by means of a winch or windlass, located on the inner edge of the dam.

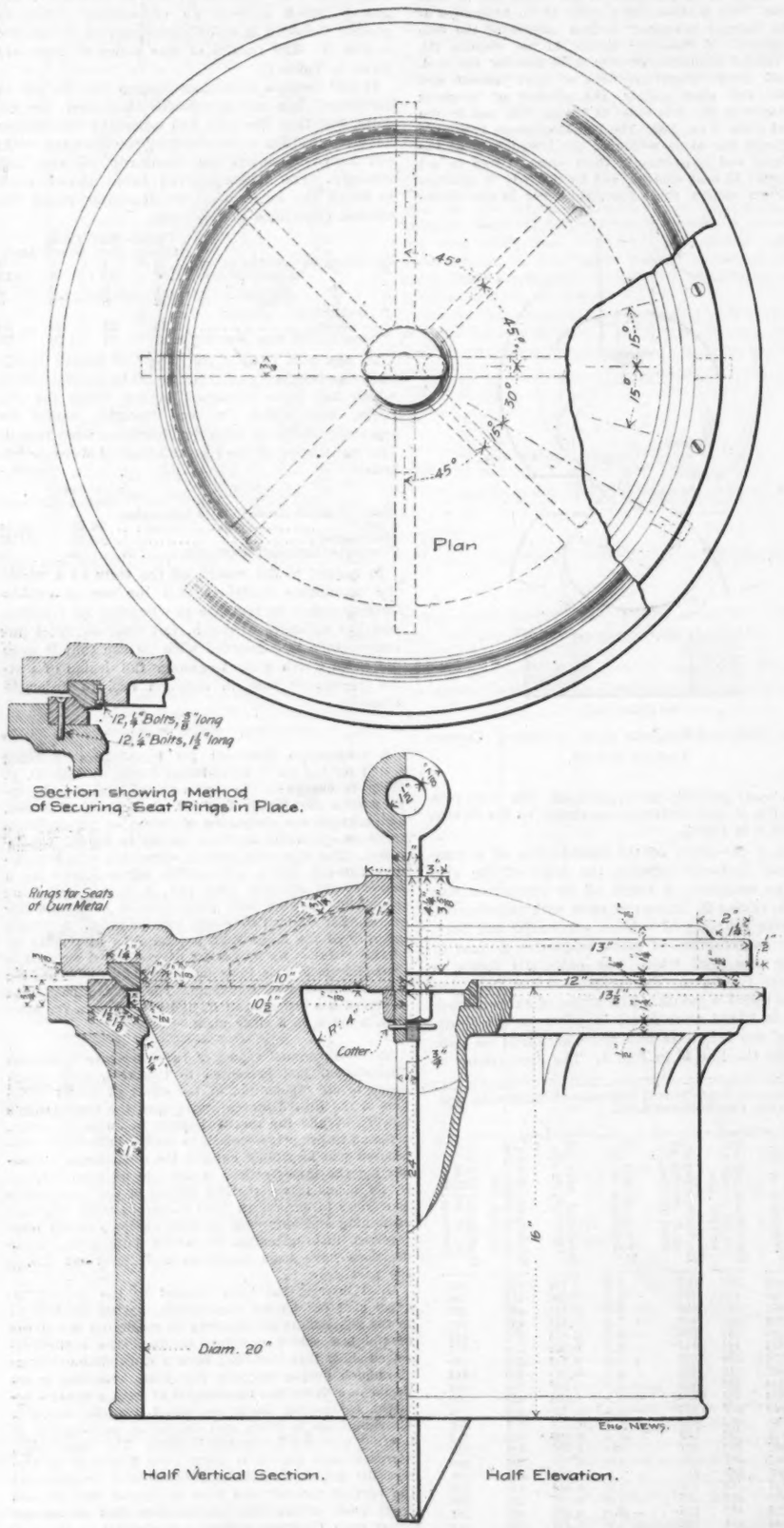


FIG. 5. DETAILS OF COVER VALVE FOR INTAKES AT CONCRETE DAM OF BUTTE CITY WATER CO.

Chester B. Davis, M. Am. Soc. C. E., Engineer.

MEASUREMENT OF THE VELOCITY OF AIR IN PIPES.*

By Bryan Donkin, Jr., M. Inst. C. E.

Having had occasion to use anemometers for measuring the velocity of air in pipes, the author desired to determine, if possible, how much reliance might be placed on the results obtained, and the perecentages of error with the different diameters of pipes used. Not being able to find any account of experiments where the air had been actually measured in bulk, a precaution which appeared to him necessary, he thought it desirable to undertake some himself. With this object he procured the loan of a small gasholder, on which he carried out, in 1888-89, the experiments here described, in which he was greatly aided by his assistant, Mr. Bacon. The gasholder, kindly placed at his disposal by the directors of the South Metropolitan Gas Company, was part of a small disused experimental gas plant at Vauxhall, London. Their engineer, Mr. Carpenter, gave every facility in his power for the prosecution of the experiments.

Makers of anemometers, or air-speed recorders, generally calibrate their instruments by making them revolve at the end of a long lever, noting the circumferential speed of the apparatus, and comparing it with the speed of a rotary counter driven by the instrument. A certain constant number is thus found by experiment, and is added to the counter-readings, to make the record of the instrument agree with the distance actually traversed in the circular course. The question is, whether such a method of calibration gives correct results? During the tests, the instrument is driven through still air in a circular path; but in pipes, the air passes the anemometer in a direction approximately parallel to its axis.

The conditions in the two cases are not similar. In the trials here recorded, the air-holder was loaded with weights at the top, to give a pressure equivalent to between 3 and 6½ ins. head of water. After each experiment the holder was refilled by pumping air under pressure by an exhauster driven by a small engine. Care was taken, by previous testing, to prevent any leakages. The volume of the holder was calibrated by measuring its diameter very carefully at many points, the vertical fall being indicated on a scale. With a fall of 10 ft., the capacity of the holder was found to be 1,650 cu. ft., and, corrected for 3-in. water-pressure, 1,662 cu. ft., the mean internal diameter being 14,494 ft. From the holder the air was passed to the straight pipe in which the anemometer was fixed. The time, five to seven minutes, occupied in the descent of the holder through this 10 ft. was carefully measured by two observers with stop-watches, as it passed two given points, A and B, 10 ft. apart; the counter of the anemometer being started and stopped by signals as it passed these points. The temperature of the air passing through the pipes and that of the atmosphere were observed, and the pressure of air in the holder in inches head of water. The area of the pipe, in square feet, being known, and the quantity of air delivered in cubic feet per minute being ascertained, the velocity in the pipe was determined by dividing the latter quantity by the former.

The difference of the readings of the anemometer at start and finish were shown by its counter in feet per minute, plus the correction given by the maker for the instrument. Thus the actual speed of the air through a given pipe, calculated in feet per minute from the volume of holder, was compared with the speed given by the instrument. The variations, or percentage of difference, between the speed in the pipe ascertaind from the holder and that given by the anemometer, for the different diameters of pipes, was determined in the several experiments. In many cases the anemometer was purposely placed touching one side, or the top of the pipe under test, but was usually in the center. A piece of perforated zinc was generally used, as a baffle, to direct the whole body of the air more evenly through the pipe, and was placed about 6 ft. in front of the anemometer. The latter was fixed inside the pipes, about 2 ft. from the free-discharge end. The velocity of descent of the holder was limited by its weight and by the area of its 6-in. exit-pipe. The experiments were mostly made with ordinary rough and rusty cast iron gas pipes, between 8 ins. and 24 ins. diameter, and between 9 ft. and 12 ft. long, but in one trial a zinc pipe 8 ins. in diameter was employed. The trials were varied by increasing the weight put upon the top of the holder, to give additional velocity in the different pipes used. The ordinary weight was about 2,583 lbs. When it was desired to increase the pressure, extra weights, equal to 2,468 lbs., were placed on the top. In the latter case the addition of the two figures shows the total weight used. During some of the experiments Professor Kennedy, F. R. S., Professor Unwin, F. R. S., and Mr. Whipple, of Kew, were present, and the author had the advantage of their criticisms.

The anemometer used throughout the trials was new, and by one of the best makers. The blades were of

* From selected papers of the Institution of Civil Engineers.

aluminum, and the axis worked in agates, as usual. Its outside diameter was 2¾ ins., and it was firmly fixed inside the pipe by a thin upright, ⅝ in. in diameter, bolted to the bottom of the pipe. For stopping and starting the counter at the moment when the holder passed the two points on the vertical scale, a special engaging and disengaging tackle was used, worked by a lever outside the pipe. The author's own anemometer was employed in nearly all the experiments, but trials were also made with one lent by Professor Unwin; the results were practically the same. The maker's correction of 30 to the number of revolutions, or velocity in feet per minute in the pipe, has of course been added. The front of the anemometer was fixed in each pipe at right-angles to the air-current, and care was taken that the pipe was not stopped in any way. The duration of each experiment was governed by the time of the descent of the holder with the pipes under test, and varied from 5 to 7¼ minutes. A possible error of a second might arise during the running, start and stop of each experiment; or, say, two seconds error, which would be equal to about 1%. The time error may therefore be taken at between 1 and 2%. The calculations of the contents of the holder and the area of the pipes are probably within 2% of the truth.

Six experiments were made with the free end of a 12 1-10-in. diameter pipe, blocked up with wood pierced with a hole, in the center of which the anemometer was placed. The results were as follows: The pipe being blocked up with this disk of wood, with a circular hole as described, 8⅛ ins. in diameter (area = 50⅝ sq. ins.), the anemometer reading was found to be 23% in excess of that given by the calculated contents of the holder, with a water-pressure on the holder of 3 ins. head, and a velocity of air through the hole of 610 ft. per minute. The same experiment repeated with a 7⅛-in. square hole (area = 50¾ sq. ins.), showed the anemometer reading to be 24¾% in excess of the calculated speed as derived from the holder. This method of measuring air by the anemometer cannot therefore be considered accurate.

A summary of the experiments is given for pipes 8, 10, 12, 14, 18, 20, and 24 ins. in diameter, at two different water-pressures, viz., 3 ins. and 6½ ins. head in the holder.

The speeds of air varied in the center of the pipes between 73 and 690 ft. per minute. It will be seen that with the lower pressure (3 ins. head), and with the anemometer fixed in the center of the pipe, and without baffle, the anemometer speeds in feet per minute are nearly always faster than the calculated speeds. The percentage, however, varies in the different pipes between 14½% fast in the 8-in. pipe and 7½% fast in the 18-in. pipe. With the 24-in. pipe the anemometer reading was 13½% slow with 3 ins. head, but only ½% fast with 6½ ins. The effects of inserting a disk of perforated zinc, called a baffle, some feet in front of the anemometer, may be seen in the table. In pipes of certain sizes, the baffle seems to bring the anemometer and calculated holder readings more nearly together. With the 24-in. pipe and the higher pressure only, the anemometer at the center of the pipe, practically agrees with the holder readings. The percentage of error of the anemometer is also given, when the instrument was placed quite near to the side or to the top of the pipes; in a 14-in. pipe, the percentage of error is very small. The effect of painting a pipe inside is shown by the difference in the anemometer speeds with the instrument at the sides of an 8 in. pipe, causing the anemometer to go about 3½% faster than when the pipe was rusty. The paint did not, however, effect the velocity of the anemometer if placed at the center of the pipe, as might be expected.

The practical conclusion to be drawn from these experiments seems to be that anemometers for the measurement of velocities of air in pipes of these diameters should be used with great caution. It will be seen that the percentage of error is not constant, and varies considerably with the diameter of the pipes and the speeds of air. A baffle, on the whole, is advisable.

Probably a simpler and more accurate way of arriving at the quantity of air delivered by a given pipe is the following: A small thin bent brass pipe, about 3-16 in. in diameter, is held with its open end facing the current of air, and is connected by a rubber pipe to an ordinary U water-gage. The mean water-pressure over the whole area can thus be carefully obtained. The mean head of water being given, the speed of air can easily be calculated by the well known formula or taken from a table; as, with a given water-pressure, there is a corresponding speed of air. This velocity, multiplied by the area of the pipe, will then give the quantity required. The total area should be divided into, say, ten equal parts, the pressure carefully taken in the center of each, and the mean thus obtained. The pressure is obtained by a delicate gage, indicating head to 1-10 millimeter of water-pressure when required. With an anemometer in pipes, this is more difficult, and takes a much longer time. Putting a 2¾-in. anemometer into the center of, say, a 24-in pipe, can hardly be expected to give the true mean velocity of the air in motion. This, however, has frequently been done, and the table shows the errors likely to arise from such a course.

Summary of Experiments on Velocity of Air in Cast-Iron Pipes Between 8 ins. and 24 ins. in Diameter at two Different Pressures.

Number of experiments.	Internal diameter of pipe.	Position of anemometer in pipe.	Water pressure in holder (mean).	Time of descent of holder.	Temperature of air. Emitted from pipe.	Temperature of air. Atmosphere.	Velocity of air. By anemometer + 30.	Velocity of air. Calculated from holder.	Per cent. of error of anemometer, assuming holder to be correct. No baffle.	Per cent. of error of anemometer, assuming holder to be correct. With baffle.	Remarks.—Baffle means a sheet of perforated zinc. Length of pipe, 9 ft. to 12 ft. Capacity of holder for 10 ft. drop = 1,662 cu. ft for 3-in. pressure. All with Mr. Donkin's anemometer 2 ft. from end of the pipe.
	Inches.		Head in inches.	Minutes.	° Fahr.	° Fahr.	Feet per minute.	Feet per minute.	Per cent.	Per cent.	
1-2-3	8	At center	3.0	6.9	60.0	63.0	790.0	690.0	14.5 fast	....	Rough pipe.—Experiments 2-3-21, with same pipe painted inside; error was practically same, or 14.3% fast.
4-5-6		At side	3.0	6.93	57.0	62.0	755.5	686.6	10.0 "	....	Rough pipe.—Experiments 23-24, with same pipe painted inside; error was 13.5% in excess of holder. Effect of paint is here seen.
91-95	10¼	Center	3.12	6.375	38.0	38.0	541.7	448.6	11.8 "	....	Inside of pipe rough.
96-97		top.	3.12	6 36	38.0	40.0	503.7	450 5	11.8 "	....	" "
98-99		"	3.12	6.40	38 0	40.0	481.5	445.9	....	8.5 fast	" "
101-102		Center	3.12	6.42	39.5	39.5	501.1	443 7	....	13.6 "	" "
8-9	12⅛	"	3.0	6.83	70.0	70.0	339.0	305.0	11 1 "	....	" "
10-11-12		Side	3.0	6.78	67¼	67.0	327.0	307.0	6.5 "	....	" "
85-87	14⅛	Center	3¼	6.66	37 0	38.0	247.2	230.1	....	7.4 "	" "
92-93		"	3¼	6.61	37.0	39.5	261.3	234.8	14.0 "	....	" "
88 89		Top	3¼	6.66	37.0	38¾	235.1	230.1	....	1.3 "	" " Very nearly right.
90-91		"	3¼	6.62	37 0	39.0	237.7	231.4	2.7 "	....	" "
78-79		Center	6.5	4.9	40¾	39¾	349.7	315.7	10.7 "	....	" " Higher air pressure in holder. All the above experiments at a about the same pressure.
84-85	14⅛	"	6 5	4.91	41.5	40.0	337.3	314.6	....	7.2 "	Inside of pipe rough.
81-81		Top	6.5	4.88	42.0	41.0	323.3	316.8	2.0 "	....	" " Very nearly right.
82-83		"	6 5	4.89	41¼	40.0	334.2	315.7	....	5.8 "	" "
32-33	17¾	Center	3.0	6.82	73.0	71¾	150.5	140.0	7.5 "	....	" " Lower pressure.
34-35		Side	3.0	6.81	75.0	73.0	126.0	140.0	10.0 slow	....	" " " " Anemometer slower than holder for first time.
68-69	20	Center	6.5	4.93	38 0	35½	165.7	155 9	....	6.2 "	Inside of pipe rough. Higher pressure.
74 75		"	6.5	4.89	41.0	38 0	172.0	157.3	9.3 fast	....	" " "
70-71		Top	6.5	4.88	39.0	36 0	161.9	157.5	....	2.8 "	" " " Two methods agree practically.
72-73		"	6.5	4.87	41.0	37.5	155.2	157.7	1.58 slow	....	Inside of pipe rough. Higher pressure. Two methods agree practically.
38-39-40	24	Center	3.1	7.19	58.0	59.0	63.5	73.6	13.66 "	....	Inside of pipe rough. Lower pressure.
47-48-49		"	3.1	7.2	45.0	43.0	53.92	73.41	....	26.55 slow	" " "
42-43-44		Top	3.1	7.2	59.0	58 0	50.12	73.40	31.85 "	....	" " "
50-51-52		"	3.1	7 2	45.0	47.0	44.4	173.5	...	39.6 "	" " "
58-59		Center	6.5	4.9	44¼	45¼	104.9	108.9	....	3.67 "	" " Higher pressure.
66-67		"	6.5	4.85	43¾	43¾	110.3	110.0	0.27 fast	....	" " " Two methods agree practically.
60-61		6 in. above center	6.5	4.9	44.0	45¼	108.6	108.9	....	0.27 "	Inside of pipe rough. Higher pressure. Two methods agree practically.
62-63		top.	6.5	4.9	44.0	45½	99.9	109.1	....	8.43 "	Inside of pipe rough. Higher pressure.
64-65		"	6.5	4.86	46.5	47¾	97.2	109.8	11.47 slow	....	" " "
25-26-27	8⅛	Center	3.0	6.74	64 0	66.0	746.7	677.7	10.2 fast	....	Zinc pipe. All above with cast-iron pipes. Lower pressure.
28-29-30		Side	3.0	6.87	65½	69.0	704.0	666.7	5.6 "	....	" " "

Aluminum is being used in the construction of racing "shells" for the universities of Cornell and Harvard. The 8-oared shell for Cornell is being built by Mr. Gatanaugh, of Philadelphia. The boat will be made wholly of aluminum, 1-20 in. thick. A single shell made by the same builder last year showed great strength and marvelous lightness. Twelve other aluminum boats are ordered from the same firm.

THE MOVEMENT FOR BETTER ROADS.

There is some earnest and intelligent work going on at present in the interest of better country roads. The National League for Good Roads, recently organized at Chicago, is seeking to enlist the railways of the United States in the improvement of roads as feeders to the various systems, and is meeting with encouraging success. This league will probably hold a meeting of the general board in Philadelphia, about Dec. 1, and, judging from the influential and representative men upon that board, some very definite action can be expected. One of the objects of this meeting will be to further the passage of the bill proposed by the U. S. Senate last July, but attacked in the House as "an invasion of state rights." This bill really asks for the creation of a national highway commission whose duty it should be to prepare for the Chicago Exposition an exhibit of the various processes of road-making as adapted to various sections of our country. Such an exhibit would be a valuable object lesson, and materially assist in teaching the people what good roads really are, and show them how much money they annually waste in ill-advised "road mending."

Besides the work of the National League we have the State Road Convention lately held in Missouri, with 800 delegates present; the Road Congress held at Memphis this month, and the good work being performed by the state commissioners of Massachusetts, Rhode Island and a few other states. The report of the Massachusetts Commission will be issued shortly, and, judging from their preliminary report, the statistics gathered and the line of work blocked out will be of much value to other states interested. The Rhode Island Commission, like its neighbor, has been carefully inspecting the main thoroughfares of the State with a view to remedying existing conditions, and it will make its report in January, 1893. This commission has personally traversed about 350 miles or roads in the state, noting present condition and the road making materials lying nearest to the points of proposed use. They already find, as any observer can find in many other places, that too many roads are built of sand and loam, within easy reach of gravel beds or rock suitable for crushing.

It is the purpose of these commissions to teach the people that it is cheaper in the long run to use the more expensive material. When once this fact is

fully realized, together with the increased comfort in travel and gain in tractive power, individual thrift and common sense can be depended upon for carrying on the good work. The bulk of our bad roads are due to ignorance of better methods rather than to deliberate neglect or an idea of economy in cost. The general community must be taught that well-built and properly maintained roads pay. Until this is done, or at least some fair beginning is made in this direction, the money can never be raised in the amounts that proper road construction demands. As a proof of the real value of good roads it is asserted that though Union County, New Jersey, has assumed a debt of $500,000 expended in the construction of new roads, real estate has increased so rapidly in value that the tax rate is lower now than when the debt was assumed.

Bills without number have been framed, and in many cases presented to state legislatures, prescribing the methods of road construction, the duties and powers of the engineering force in charge, recommending the use of convict labor in this construction, or in otherwise fixing the character of the laboring element. While it is a foregone conclusion that good roads will require engineering control in their construction and maintenance and that the best engineers can do nothing without capital and labor to back them, legislation of this kind just now represents effort wasted. The people must be educated first, and this can best be done by awakening public interest through the intelligent working of state commissions, national leagues and local organizations. This is now practically the line of action of the active bodies of this nature; and while they are studying and discussing the ways and means the real value of their work lies in teaching their several constituencies to do some thinking for themselves. It is the people, and the whole people, those living in cities as well as the farming classes, that will be benefited by better highways and that must eventually pay for them.

It is not a problem for the national government to solve, and our government cannot solve it after the methods followed in Europe; the conditions are altogether different. To be consistent we should have to place our railways, canals, telegraph lines and all else of public need under a similar control. A national commission might better gather statistics and send out information to the public than private parties; but the several States should do their own legislation, as best suits their individual needs and resources. This is the point of view very properly taken by the National League, and it is on these lines that the state commissions referred to are now doing good work. Everybody wants improved highways; but the trouble is that the mass of the people do not want to pay for them, simply because this majority does not yet appreciate the true value of the investment and the personal benefit of a change from existing conditions. The present campaign is thus really an educational one, and its purpose is to awaken public interest and to suggest a line of action that will later crystallize into concerted and systematic effort and a general remodeling of our whole network of highways.

A HIGHWAY BRIDGE FAILURE NEAR FRANKFORT-ON-THE-MAIN, GERMANY.

Another instance of too great economy on the part of municipal authorities is brought to our attention by the collapse of a highway bridge over the Nidda River, near Frankfort-on-the-Main, Germany, as described in the "Centralblatt der Bauverwaltung." In this case, however, it would appear that the weakness of the bridge was known by the municipal authorities, for they had taken the precaution to post a sign prohibiting more than one loaded wagon on the structure at one time. Their chief fault, then, taking the most charitable view, seems to have been a too great faith in the German peasant's respect for the law, a mistake in the judgment of human nature, if German human nature is anything like American human nature, which is hardly more complimentary to their intelligence than if the bridge had been built weak for reasons of the gross ignorance which its design seems to show. It is stated that the immediate cause of the failure was the passage of a steam road roller weighing 17½ tons hitched to a work wagon weighing 2 tons. Bridge engineers will easily read the reasons of the disaster in the design.

According to the somewhat meagre description given the bridge consisted of two trusses shown in diagram in Fig. 1, placed 16.4 ft. apart and carrying a roadway 9.85 ft. wide and two sidewalks. Its clear span was 87½ ft. The top and bottom chords of each truss consisted of a web and two angles, with two cover plates near the

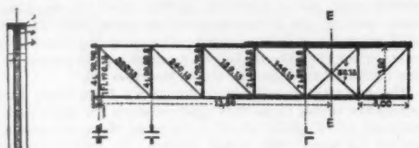


Fig. 1. Diagram of Truss.

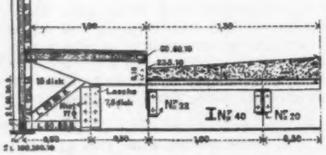


Fig. 2. Cross Section m-m.

center. The vertical posts, or compression members, were made up of couples of either two or four angles as shown in Figs. 1 and 2, which, as far as we are able to discover, either from the illustrations or text, were unconnected either by riveting or latticing, except at the end posts where a web was introduced. The diagonals were simply iron straps as also were the sway braces underneath the flooring. As near as we can make out the flooring consisted of transverse trough sections supported by stringers fastened to the floor beams by angles. The connection of the floor beams to the trusses is effected by means of gusset plates riveted to the floor beams, with a butt joint, by a small splice plate 9-32 in. thick.

The defects of the design are self evident. After the failure it is stated that the top chord of one truss showed a sharp bend while the top chord of the other truss was twisted. The bridge had been in use but two years, and had never been subjected to any test.

LEAD-LINED IRON WATER SERVICE PIPE.

The advantages of lead as a material for water service pipes are well known by water-works officials and engineers. One of its chief advantages over iron is its comparative immunity from serious chemical action by water or any chemicals which may be present in the water. Iron service pipes are galvanized, enameled, tar coated and cement-lined in order to prevent corrosion or other chemical action but whenever such pipe is cut and often when it is bent unprotected iron is exposed to the action of the water.

A lead-lined service pipe has been devised by Mr. Geo. W. Harrington, Superintendent of the Wakefield (Mass.) Water Co. and is now being manufactured at Wakefield by the New England Water Pipe Co. This pipe is designed to give all the advantages of lead pipe without using the large amount of lead which is necessary for pipe under heavy pressure.

In manufacturing the pipe ordinary iron pipe is used. In this a thin lead pipe of smaller diameter is inserted and then expanded to fit the iron.

When a length of pipe is cut the exposed ends of iron are protected with lead in the manner shown in Fig. 1. The tool at the right is inserted in the end of the pipe to press the lead against the iron. A thimble is then inserted and driven home by the tool, which trims off all surplus lead and forms a lead bead at the end of the pipe. When a thread has been cut on this pipe and the pipe screwed into a fitting, the thread on the fitting screws against the beaded end of the thimble, mentioned above, so that no part of the pipe is exposed to the action of the water.

Fig. 2 shows a piece of pipe at the right, with a thimble, screwed into a lead-lined coupling.

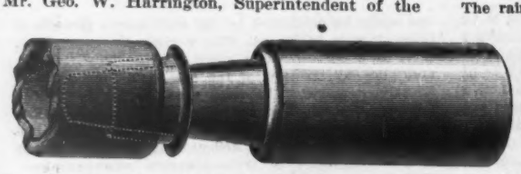


FIG. 1. METHOD OF PROTECTING END OF LEAD LINED IRON WATER PIPE

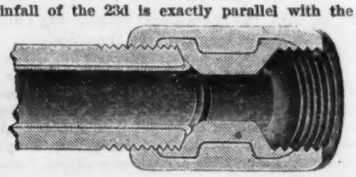


FIG. 2. END OF PIPE, WITH LEAD THIMBLE SCREWED INTO LEAD-LINED COUPLING.

WATER SUPPLY AND TYPHOID FEVER IN THE VALLEY OF THE TEES, YORKSHIRE, ENGLAND.

The following interesting account of an outbreak of typhoid fever is taken from a paper on "The Pollution of Streams" by Mr. P. H. Bryce, M. D., of Toronto, Ont., which he read before the National Conference of Boards of Health at Lansing, Mich., June 6, 1892. A partial abstract of the paper was given in our issue of June 30, 1890:

The details of an outbreak in the cities along the valley of the Tees, in Yorkshire, England, which occurred in August and September, 1890, are so admirably set forth in the report for 1891 of the Local Government Board of Great Britain, that I cannot forbear referring to them.

The outbreak began in August, 1890, a great increase in the typhoid cases for the fortnight ending September 20, being noticed, which increase continued till October 4. In four weeks 570 cases occurred in 550 houses. In all the area, made up of some 13 registration districts, there was a total population of 520,000, nearly all of whom were supplied with water, passed to subsidence tanks, thence through sand filter beds, from the Tees. The water was supplied by two companies, their intakes being but a few score yards apart, at a point two miles above Darlington, at Broken Scaur. The amount of water daily pumped was about 11,000,000 imp., or 13,200,000 U. S. gallons.

During the four weeks the exceptional prevalence was limited to the area so supplied, 41,000 houses being supplied by the companies, 6,000 were supplied from other sources. The rate of excess was calculated by the house, there being 12 cases per 1,000 in those supplied by the companies, and less than 1 per 1,000 in houses supplied from other sources.

What was remarkable was that several hamlets along the river above, getting water out of the river, but not from the water company, escaped.

Above the source of supply the drainage area of the river covers 300 sq. miles, and the water flowing past the pumping station in times of drought amounts to 45,000,000 imp., or 54,000,000 U. S. gallons. Over this drainage area are scattered 15,000 persons in numerous villages and farmhouses. Some fifteen or twenty villages up to Barnard Castle are situated along the river. The nearest is half a mile above the intake pipe, with 33 houses whose drainage runs into an old cesspool, with an overwash during rains into the river. The next town is 2½ miles up the river with 60 houses; and the next 6 miles up with 170 houses.

The sewage from the last has its watery portion flowing over into the river, the rest drying alongside of a ditch which is washed out with floods.

The next town is 7 miles up, and the next is 10 miles, with 300 houses polluting a branch of the Tees. At 15 miles above is a town of 1,000 houses.

The heaviest rainfall in the valley during the period occurred in the fortnight ending August 23. The river was in flood on the 13th; also on the 23d.

The rainfall of the 23d is exactly parallel with the incubation period of typhoid, which preceded this general diffusion. The town authorities have for years recognized the liability of the river to severe pollution, which occurs during flood time. In 1887 analyses were made biologically and chemically, the report of which states:

That on a sudden rise of the river's flow, and for 48 hours after its onset, there is great increase of organic matter at the pumping station, and abundant evidence of unaltered sewage.

The filtering processes greatly reduce the amount of organic matter, but during high water the town water

shows presence of organic pollution, which is, in part, composed of fresh sewage unaltered."

None of the towns above suffered from any epidemic of typhoid during this period, although several isolated cases had appeared.

Dr. Barry ends his report on this outbreak with the following conclusion:

That if the sewage and excremental and other refuse were kept out of the river, the danger of specific pollution would be greatly reduced, but even under these circumstances it is still doubtful whether a water pumped from a river at a point upward of forty miles from its source is, anywhere in this country, a desirable supply for drinking purposes.

A street indicator for electric cars has been tried recently by the Albany Ry. Co., of Albany, N. Y. A similar method of announcing the names of cross streets, used for a time on the South Chicago cable roads, was worked by the gripman, and it was found to be more than the gripman could attend to. The Albany indicator is placed inside the car over the door, and consists of a series of narrow signs so arranged that only one is visible at a time. The indicator is operated automatically by a current from the trolley wire. A finger projects down from the trolley support wire near each street corner in such a way as to strike a trigger on the trolley arm of the car. The effect of this is to turn the indicator one notch, so as to display the name of the street which the car is approaching, and ring a bell to attract the attention of the passengers. As these fingers are at some distance from the street corners, passengers are warned in time to notify the conductor where they want to stop. It is said to be a decided improvement on the oral method of announcing the names of streets, as there is no danger of misunderstanding the name, and it eliminates the frequent opening of the car door in cold weather. As soon as the car reaches the end of the line the reversing of the trolley changes the mechanism of the indicator, and the signs are reeled off in reverse order.

The latest reported case of water-pipe corrosion caused by the ground current of an electrical circuit is in Boston, where it is claimed that the ground current of the West End Street Ry. has affected the gas and water pipes and the underground telephone cables. According to an electrical contemporary, which might naturally be expected not to overstate the case against the electric railway, constant complaints are received by the water department of leaks caused by corrosion of water pipes. It is even said that in connecting gas mains when relaying, arcs have formed between the ends of the pipes, setting the jute packing on fire. In our issue of Dec. 8 (p. 549), we published some remarks of Mr. Pearson, Electrician of the West End Street Ry. Co., on the necessity of an ample metallic circuit for the ground return of electric street railways. These are now especially interesting in this connection. It may yet be found expedient to require the provision of an ample metallic path for the return current in granting franchises for electric street railways. The use of continuous rails may, perhaps, aid in solving the difficulty.

The Manchester Ship Canal Co. is to receive from the city of Manchester a further loan of $10,000,000 (making $25,000,000 in all), and the company will give the city a majority of one on the board of directors, the number to be increased to 21, of whom 11 will be representatives of the city. The shareholders, who have invested $40,000,000, should, however, it is urged, have control over the revenue administration, including the fixing of tolls and rates, and it is pointed out that their only motive must naturally be the rapid development of the earning power of the canal. The cities of Salford and Oldham propose to advance the company $5,000,000 and $1,250,000, respectively.

An omnibus or stage, with pneumatic tires, has been tried by the Glasgow Tramway Co., at Glasgow, Scotland, and is said to be a very comfortable vehicle to ride in. The inside seats are mounted on springs, which adds much to the comfort. There is an electric lamp fixed in the roof, supplied by a box underneath one of the seats containing a sufficient storage of electricity for 24 hours. Twelve passengers can be carried inside and 14 outside. The tires are about 3½ ins. diameter, and can withstand a pressure of 187 lbs. to the sq. in. To guard against any risk of the indiarubber being punctured by sharp stones or otherwise, the tires are thoroughly protected by several plies of canvas, with a covering of wire-wove netting.

PERSONAL.

Mr. J. W. Kendrick has been elected City Engineer of Birmingham, Ala.

Mr. John H. Dockweiler has been re-elected City Engineer of Los Angeles, Cal.

Mr. Wm. Barclay Parsons, M. Am. Soc. C. E., has been elected a Member of the Institution of Civil Engineers.

Mr. H. H. Vreeland has been appointed General Manager of the New York & Northern Ry., and the office of the General Superintendent has been abolished.

Capt. Alfred E. Hunt, President of the Pittsburg Reduction Co., delivered a lecture on "Aluminum," at Troy, before the students of the Rensselaer Polytechnic Institute, Dec. 15.

Mr. Albert Smith, of Saltsburg, Pa., is at Corry, Pa., in charge of main sewer construction, which has been resumed after some six months' delay caused by a defective city charter.

Mr. T. M. Bates, Superintendent of Transportation of the Chicago & Alton R. R., has resigned, and will be succeeded by Mr. W. E. Gray, Superintendent of the Kansas City, Osceola & Southern R. R., at Kansas City, Mo.

Mr. James P. Thomson, a graduate of the Rensselaer Polytechnic Institute in '88, died Nov. 27, at Charleston, Wash., where he was employed by the government upon the construction of the Puget Sound dry dock and naval station.

Mr. Frederick H. Lewis, late manager at Philadelphia for the Pittsburg Testing Laboratory, will after Jan. 1, 1893, take charge of a department of mechanical testing and inspection for Messrs. Booth, Garrett & Blair, of Philadelphia. This department is to be added to the metallurgical and chemical departments of this well known firm.

Mr. B. H. Hull, C. E., Bridgeport, Conn., has completed a large dam on the Housatonic River for the Monument Mills Co. The working head is 20 ft. and average power 600 HP. The head race and wheel pits are also completed. The work has been approved by Mr. D. M. Greene, engineer for the County Commissioners.

Mr. William M. Derby died at Chicago, Ill., Dec. 6. In 1857, when the Illinois Central R. R. was engaged in extensive improvements, under the direction of Gen. George B. McClellan, Chief Engineer, Mr. Derby secured a contract for the construction of the breakwater on the lake front, and carried the work to completion. He continued for some time afterward the business of a contractor, constructing among other works the court-house at Geneva, Ill.

Mr. Ludwig Hagen, Geheimer Ober-Baurath and professor of civil engineering, died in Berlin Nov. 19, 1892. He was the eldest son of the late Ober-Landes Baudirector Gotthilf Hagen, author of a well known German work on hydraulics. Mr. Ludwig Hagen was Chief Engineer of the Saar and the Ihle canals and succeeded his father as Superintendent of Harbor Works on the Baltic Sea, including the jetties at Pillau harbor, the successful working of which furnished further argument for Captain Eads in promoting his proposed work on the Mississippi jetties. Mr. Hagen was also an expert in coast-lighting, having carefully and personally studied the systems used in England, France and the United States. For several years he was in charge of the improvement of the Vistula River and the prevention of the disastrous freshets resulting from one of the greatest spring ice-jams known on the rivers of the world. He did not live, however, to see his plans carried out.

NEW PUBLICATIONS.

LEITFADEN DER MECHANIK (Guide to Mechanics). Elementares Lehrbuch fuer Technische Mittelschulen und zum Selbstunterricht.—By R. Lauenstein. Stuttgart: I. Z. Cotta. Small 8vo, pp. 153; 140 illustrations.

This is a concise, practical text-book, embracing the elementary principles of mechanics, the statics and dynamics of solid, liquid and gaseous bodies; supplemented by tables of coefficients of friction, specific weights, heights of fall with terminal velocities and trigonometric figures. A special feature of this work in the number of simple, practical examples with their proper solutions which accompany each chapter. The paper and printing are of the very best quality, and the illustrations are well executed. To technical students, reading German, this book will prove a valuable aid, as it is especially adapted for self instruction.

SOCIETY PROCEEDINGS.

NEW YORK RAILROAD CLUB.—At the meeting on Nov. 15 a paper was read by Alonzo Dobbeer, Supt. of Motive Power of the Buffalo, Rochester & Pittsburg, entitled, "When Should a Locomotive Be Destroyed?" The gist of the paper and of the discussion which followed was that it was generally cheaper to cut up a locomotive for scrap after it had seen 10 to 20 years of service, and purchase a new locomotive than to keep on repairing the old engine. It was generally agreed that the condition of the engine and its hauling capacity should determine when the engine should be condemned rather than its actual age.

The advantages of the system adopted by the Pennsylvania R. R. of adopting standard locomotives with their parts interchangeable, was well brought out in the discussion. The Pennsylvania has now less than ½% of its locomotives of patterns other than its standards, and those are only kept for use under some peculiar circumstances where a standard engine would not do. The advantages of this system in making repairs are very great. When an engine is condemned, but little except the boiler and parts actually worn out goes to the scrap heap. All forgings, castings, etc., find use in repairs of other locomotives of the same pattern, the demand for them being greater than the supply.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on Dec. 3, the following nominations of officers were made for the year 1893: President, John Birkinbine; Secretary, L. F. Rondinella; Treasurer, T. Carpenter Smith.

The secretary read a communication from Mr. O. Chanute, describing the plan which had been adopted for inviting the engineering societies of this country and abroad to the Engineering Congress of the World's Fair. Mr. F. H. Lewis called attention to the act of leading architectural societies of this city in passing a resolution to expel any member who submitted plans for the Bourse, because it was specified that the architect should be associated with an engineer. He suggested the matter as a fit and proper subject of discussion for the Club. No action was taken. A communication was presented from the American Philosophical Society, calling attention to the 150th anniversary of its foundation, which will be celebrated in May, 1893, and asking for the appointment of a delegate from the Club to present papers by title. Action was deferred until next meeting.

Mr. G. T. Gwilliam read a paper on "The Heating of Dwellings from a Sanitary Point of View." The Secretary read a paper by Mr. Charles S. Churchill, upon "High Speed on Railways from a Maintenance of Way and Engineering Standpoint." Mr. Churchill requested that an abstract be prepared and the subject be held open for discussion at the next meeting. The paper by Mr. Edward Hurst Brown, on "Paint as Used in Engineering Constructions," was deferred.

L. F. Rondinella, Secy.

COMING TECHNICAL MEETINGS.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Jan. 2. Secy., C. L. Annan, City Engineer's Office.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Jan. 3. Secy., Chas. S. Howe, Case School.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Jan. 3. Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
Jan. 4. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 4. Annual meeting, Jan. 18, 19. Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
Jan. 4. Secy., Arthur Thacher, Odd Fellows' Building.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Jan. 6. Secy., E. K. Smoot, 608 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Jan. 6. Secy., O. Von Geldern, 719 Market St., San Francisco.
NORTHWEST RAILROAD CLUB.
Jan. 7. Union Station, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Jan. 7. Secy., F. D. Jones, Helena.
SWEDISH ENGINEERS' CLUB.
Jan. 7. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 190 La Salle St., Chicago Secy., John Ericson.
ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 7. 1122 Girard St. Secy., L. F. Rondinella.
WISCONSIN POLYTECHNIC SOCIETY.
Jan. 9. Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
Jan. 9. Secy., Waterman Stone, Baird Building.
NORTHWESTERN SOCIETY OF ENGINEERS.
Jan. 10. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
DENVER SOCIETY OF ENGINEERS AND ARCHITECTS.
Jan. 10. Secy., Geo. H. Angell, 35 Jackson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
Jan. 10. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Jan. 11. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Jan 11. Secy., F. M. Curtis, C. C. E. R., Boston.
ENGINEERS' CLUB OF MINNEAPOLIS.
Jan. 12. Secy., F. W. Cappelen, 1628 Hennepin Ave.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Jan. 12. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
Jan. 12. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Jan. 13. Secy., D. W. Meeker, St. Paul.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 17. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
Jan. 17. Rookery Building, Chicago. Secy., W. H. Marshal.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Jan. 18. Secy., S. E. Tinkham, 36 Broomfield St.
MICHIGAN ENGINEERING SOCIETY.
Jan. 17, 18, 19. Annual meeting at Lansing, Mich. Secy F. Hodgman, Climax, Mich.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 19. Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
NEW YORK RAILROAD CLUB.
Jan. 19. Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
Jan. 19. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Jan. 19. Secy., C. F. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Jan. 20. 201 Washington Building.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 26. Secy., C. H. McLeod, Montreal, P. Q.
CENTRAL RAILWAY CLUB.
Jan. 25. S. W. Spear, E. Buffalo, N. Y., Iron Works.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21, etc. Annual meeting, Montreal, Que. Secy., R. W. Raymond, 6 Burling Slip, New York, N. Y.

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AND
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CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The article on high speeds for railway trains in our issue of Dec. 8 has called forth from Mr. S. M. Vauclain, of the Baldwin Locomotive Works, the letter which we publish in another column, a letter which is encouraging to the editor and encouraging to the believers in high speed locomotives. Mr. Vauclain says in fact that the article in question is, in his opinion, the best yet written on the important subject of high speeds. He points out the means which have made practical the speeds recently obtained (equivalent to 91½ to 97½ miles per hour) and expresses his intention of still further lowering the record to a mile in 36 seconds, or equivalent to the ideal speed of 100 miles per hour. That the piston valve, to the use of which Mr. Vauclain attributes largely the recent developments in speed, is by no means an experimental device, is proved by the large number of locomotives to which it has been applied. Early in the present year the Baldwin Locomotive Works had built over 100 of Mr. Vauclain's four-cylinder compounds, and had 50 more under contract. The use of piston valves on the newest and fastest Atlantic steamships also goes to prove their superiority to the slide valve under conditions of high pressure and high speed. It will probably be news to many of our readers that several locomotives now in service are carrying a boiler pressure of 200 lbs. per sq. in., but in view of recent developments it is most probable that a rapid advance will be made in the more general adoption of this pressure. In the article above referred to we pointed out the necessity of a further advance in air-brake practice to provide for the control of trains at what are now exceptionally high speeds, and according to statements respecting recent tests made with improvements in the Westinghouse brake a train of six passenger cars, running at a speed of 60 miles an hour on a level, can be brought to a stop in 660 to 700 ft. instead of 950 to 1,000 ft. as with the present brakes. These tests are noted in another column. The improvement in the quick acting brake is said to be in giving an initial high pressure on the brake shoes, the pressure being automatically reduced with the speed. Mr. Vauclain and Mr. Westinghouse are largely instrumental in making practicable the running of trains at very high speeds, and we confidently look for further developments.

We published last week an abstract from London "Engineering," relating the results of a competition between English and American bridge builders. Here is what another English technical journal, "Industries," has to say about American competition in locomotives:

> It is probable that the English locomotive and carriage industries will be exposed in the future to a larger extent than they have been in the past to the competition of Germany, Belgium, the United States, and perhaps one or two other countries. In those countries, as a rule, protection is accorded to the rolling-stock manufacturers, so that they are able to command high prices for home consumption—all the more so that they are limited in number. This enables them to export a certain part of their produce at a low price, and explains the success that has attended tenders of German and Belgian makers in foreign markets in competition with our own.
>
> The fact that a number of American locomotives have been adopted in Central and South American states, Japan, Australia, and elsewhere, appears to be more difficult to explain. The total number of locomotive engines exported from the United States has varied, over the last ten years, from a maximum of 10,945 in 1882, to a minimum of 6,411 in 1886, the number exported for the year 1891 having been 8,815. This represents a very large business, and it behooves the locomotive builders of this country to inquire into the secret, if any there be, of the success that has been gained by American locomotives in neutral markets. Is it due to their greater cheapness, or to their superiority of results; and if to their cheapness is it possible that English builders are following a wrong system, either in reference to the principles of construction adopted, or to the possibility of producing work that costs too much money—in other words, is too highly finished—relatively to the results sought to be obtained? It certainly appears to be inexplicable, on the face of it, that the United States, with materials at least 50% dearer as a rule, and labor paid probably 70% higher, should be able to compete so successfully in markets that English manufacturers would probably otherwise occupy.

There are none so blind as those who will not see. For years the English technical papers have been filled with discussions of the relative merits of the English and American locomotive, and the disputants, who are usually all on one side, have proved time and time again to their own satisfaction that their machines were superior to the American in speed, fuel economy, durability, etc. etc. With a curious perversity they have refused to recognize the fact that the best locomotive is the one which will handle a given traffic at least cost; and that it is in this and not in any minor mechanical details, concerning which there is much to be said on both sides, that the great superiority of the American locomotive for American traffic (and so far as Americans can see for British traffic also) is to be found. Because the conditions of traffic in Australia, South America and most other countries undergoing rapid development resemble the conditions in the United States rather than those in Great Britain, the American locomotive, notwithstanding great commercial disadvantages, has been able to compete with its English rival.

The burning of 17 locomotives in the roundhouse of the Denver & Rio Grande R. R. at Salida, Colo., on Dec. 11, is another illustration of the serious defect in the common American plan of housing locomotives. According to telegraphic dispatches, the exit from the roundhouse was over a single turntable; and the radial tracks between this and the roundhouse were so crowded with locomotives that the other locomotives inside the burning building could not be run out.

It would probably have made little difference, however, had the tracks in front of the roundhouse been clear. Every engine would have to run onto the turntable and balance; then the table would be swung to the exit track on the other side and locked; the engine would move off, and the table would be swung back to take the locomotive from another track. There is not time to repeat this series of manoeuvers many times before a destructive fire will gain such headway that further rescue is impossible.

With the rectangular type of engine house, on the other hand, an engine with steam up on any track can couple to those in front or behind and move out the whole string without delay. Two or three men can clear four or five tracks in as many minutes. Besides the advantage in case of fire, the danger which always exists with the roundhouse of putting a lot of locomotives out of service through the breakdown of the turntable is done away with in the rectangular house. We have before this recorded large losses due to these patent defects of the common roundhouse and shall probably continue to do so while it continues in general use.

It is pretty generally understood, by engineers at least, that electric heating is economical only where a small amount of heat or heat in very concentrated form is desired, as in cooking, welding, forging, brazing, smelting, etc. It is sometimes said, however, that by developing large water powers, energy can be so cheaply obtained that electric heating can compete with coal for general heating purposes. We notice for example in a report of a recent meeting of the Buffalo Electrical Society, the statement that electrical heating at $24.96 per HP. per annum would be as cheap as hard coal at $8 per ton; and the speaker said that the feasibility of electric heating about Buffalo would depend upon the policy to be pursued by the Cataract Construction Co. toward users of its power.

Now let us see what the possibilities are in this direction. One horse-power = 33,000 ft.-lbs. per minute = 1,980,000 ft.-lbs. per hour = 7,227,000,000 ft.-lbs. per annum, counting 10 hours in a day and 365 days in a year. If this mechanical energy could be all transformed into heat at the place where it was wanted, it would produce 7,227,000,000 ÷ 772 = 9,361,400 heat units. Since a pound of good coal produces in its combustion about 14,000 h. u., we have a total heating effect equal to that produced by 9,361,400 ÷ 14,000 = 668 lbs. of coal. For a horse-power acting 24 hours in the day, the yearly equivalent in coal is 668 × 2.4 = 1,603 lbs. The cheapest water power in the world, doubtless is that which will soon be furnished by the Cataract Construction Co., and the lowest rate at which it has made contracts is, we believe $5 per HP. per annum. Allowing nothing for losses by either method, this would be equivalent to coal at $6.25 per ton; but the coal can be burned when it is needed, whereas the heat obtained from the mechanical energy of the falling water is a constant, uniform flow all the year round. Considering the fact that the rate of flow must be equal to that required for use on the coldest winter's day and that for about six months of the year artificial heat is of no use whatever, the contrast in economy between the two methods ought to be apparent to any one; if it is not, a comparison of the cost of plant for the two system of heating will serve as a clincher.

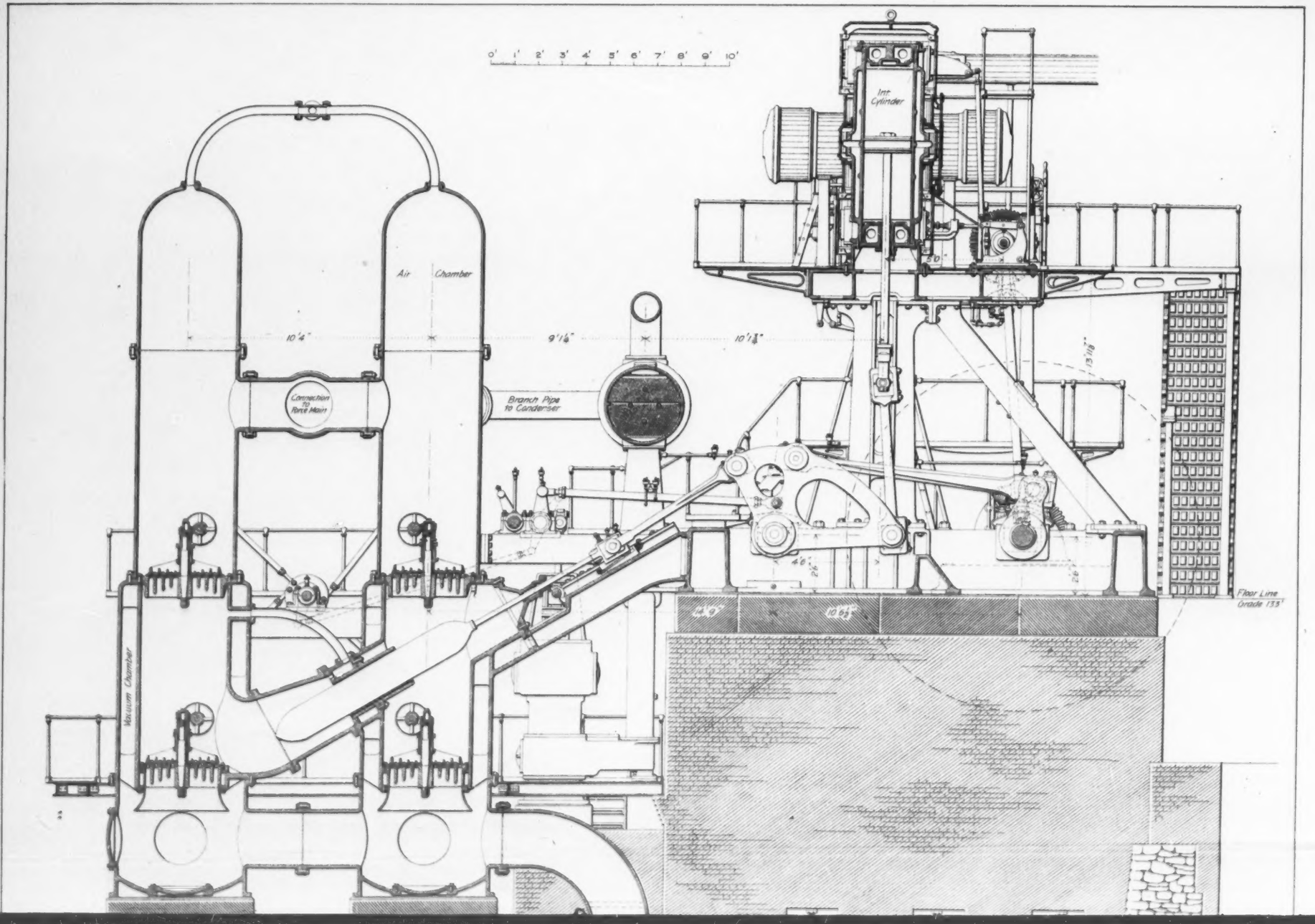
To give a more vivid illustration of the enormous amount of energy required to produce a small amount of heat: If all the enormous power of Niagara Falls, estimated at 3,000,000 HP., were converted into electricity and that into heat with no loss, the total heating effect in a year would be equaled by the combustion of 2,146,000 tons of coal or less than one-third as much as was carried by rail to Buffalo in 1891.

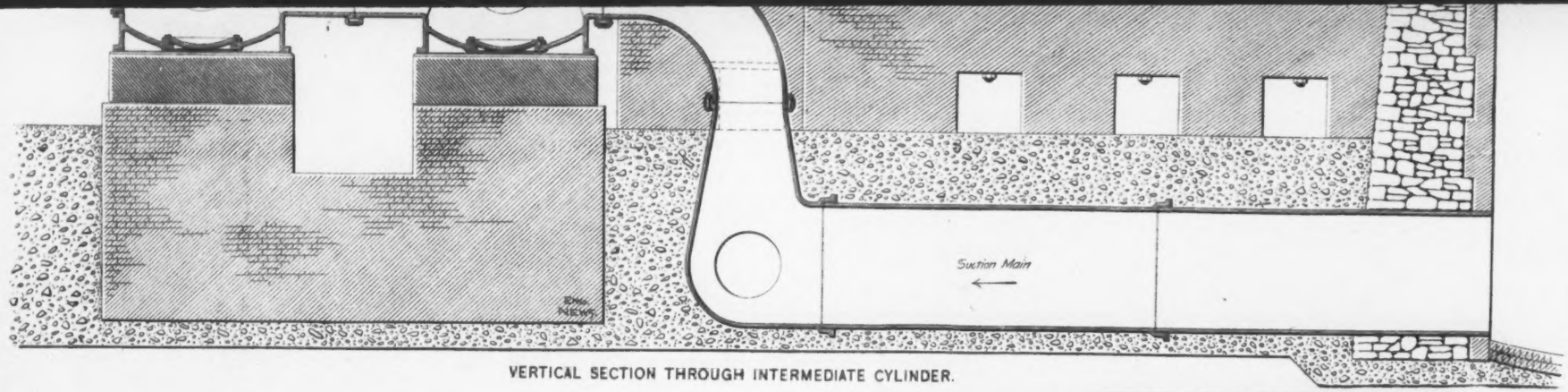
PLATE AND WIRE GAGES.

At a recent meeting, reported in our issue of Dec. 8, the American Society of Mechanical Engineers took positive action in favor of the final abandonment of all existing sheet metal and wire gages, and the use instead of gage numbers indicating directly the thickness of the plate, or diameter of the wire, in thousandths of an inch; "No. 20" meaning plate or wire 0.020 in. thick, "No. 50," 0.050 or 1-20 in. thick, etc. This has been suggested from time to time for the last half-century. It has certain obvious and great advantages, not the least of which is, that whether an ideal system for any one material or not, it would do away at once with an infinity of different gages for different metals and uses of the same metal, and also of various non-metallic substances like paper, glass, leather, slate and what not. To the older gages, moreover, new ones are constantly being added. It was the very proposal to establish a new one for sheets and plates which brought the subject before the society.

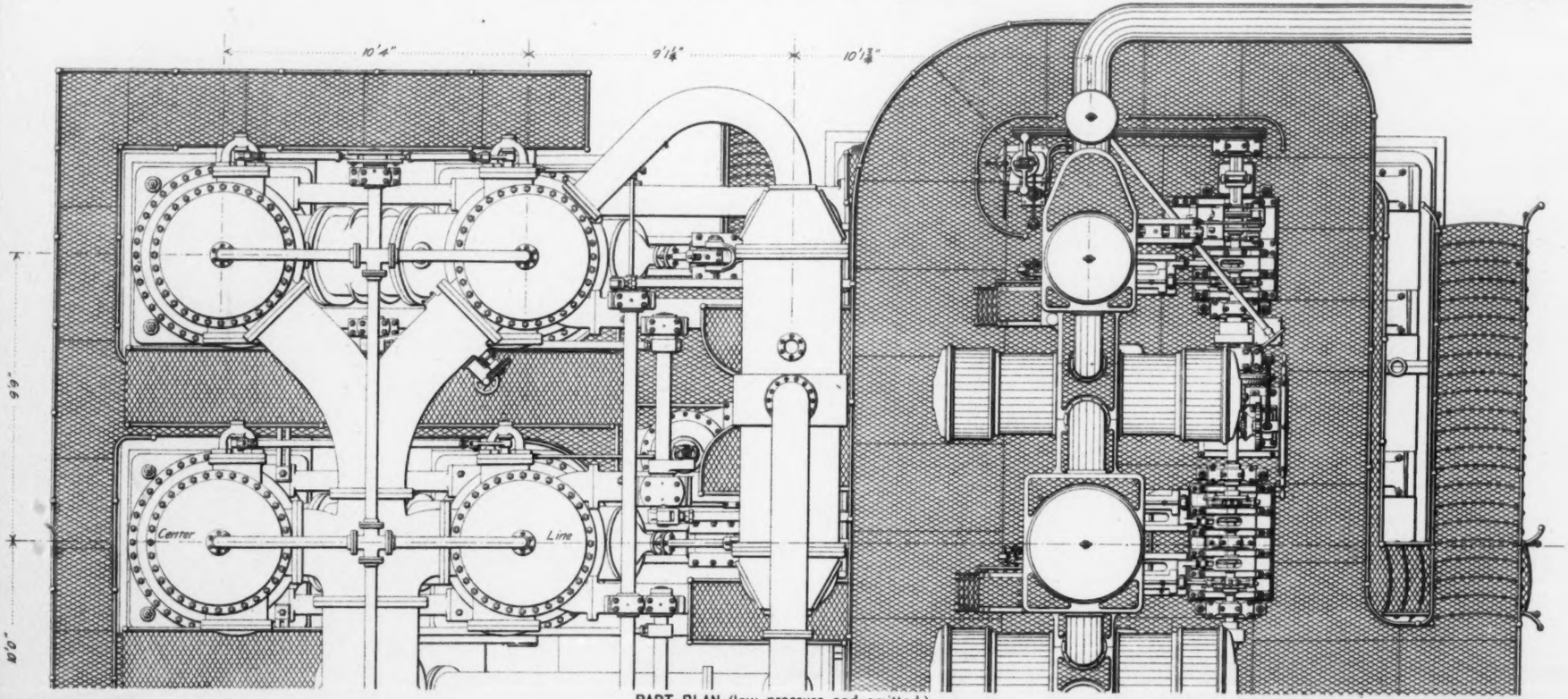
The action went no further than the appointment of a committee, but this was done by amendment of a resolution to recommend to the members of the society, there and then, the use of the inch gage exclusively in all designations of small thicknesses and diameters. The debate showed that with the demand itself the members present sympathized almost unanimously, and nothing but a feeling that such important action should not be taken so summarily, presented the resolution passing "nem. con.," so far as could be judged from appearances. A strong argument advanced in favor of doing so was that the micrometer gages now so common, reading to thousandths of an inch, would be available for this use without any additional expense or inconvenience.

But there is a difficulty on the other side which was not alluded to in the discussion, but which we fear will prove a serious obstacle to the introduction and general use of the inch gage. The ideal

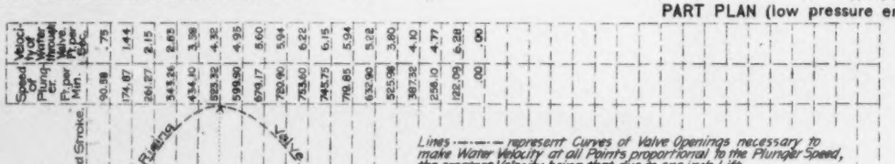

0' 1' 2' 3' 4' 5' 6' 7' 8' 9' 10'
Int Cylinder
Air Chamber
10'4"
9'1¼"
10'1⅜"
Connection to Force Main
Branch Pipe to Condenser
Vacuum Chamber
Floor Line Grade 133'



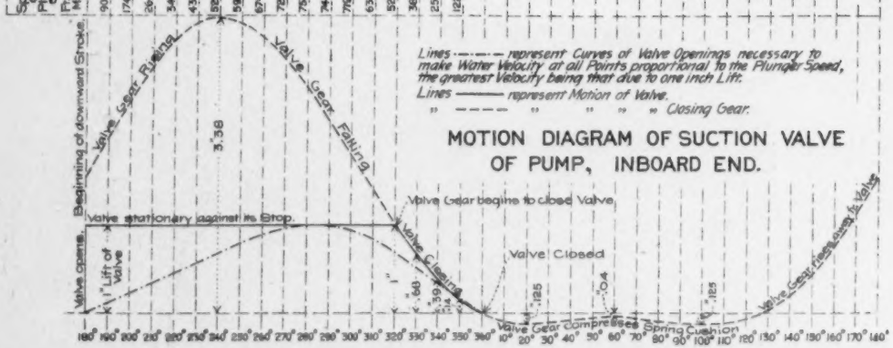
VERTICAL SECTION THROUGH INTERMEDIATE CYLINDER.



PART PLAN (low pressure end omitted.)



HIGH SERVICE PUMPING ENGINE (20,000,000 Gallons Capacity)


Lines ·—·—· represent Curves of Valve Openings necessary to make Water Velocity at all Points proportional to the Plunger Speed, the greatest Velocity being that due to one inch Lift.
Lines ——— represent Motion of Valve.
" – – – " " " " Closing Gear.
Valve Gear Rising
Valve Gear Falling
3.38
Beginning of downward Stroke
Valve stationary against its Stop
Valve opens
Lift of Valve
Valve Gear begins to close Valve
Valve Closed
Valve Closing
.540
.339
.125
.04
.125
Valve Gear compresses Spring Cushion
Valve Gear releases Valve
180° 190° 200° 210° 220° 230° 240° 250° 260° 270° 280° 290° 300° 310° 320° 330° 340° 350° 360° 10° 20° 30° 40° 50° 60° 70° 80° 90° 100° 110° 120° 130° 140° 150° 160° 170° 180°

MOTION DIAGRAM OF SUCTION VALVE OF PUMP, INBOARD END.

HIGH SERVICE PUMPING ENGINE (20,000,000 Gallons Capacity) FOR BOSTON WATER-WORKS.

E. D. Leavitt, M. Am. Soc. M. E., Designing Engineer.

Wm. Jackson, M. Am. Soc. C. E., City Engineer of Boston.

The Quintard Iron Works, New York, Builders.

CHAS. HART & SONS, LITH, 96 VESEY ST., N. Y.

gage for small thicknesses or diameters should increase, not in an arithmetical but in a geometric ratio. Each number of the gage should differ from the preceding not by some constant amount, but by some constant fraction of its own value, like 1-5, 1-8 or 1-10. From this it follows that the successive values of an ideal wire gage should vary according to the compound interest formula.

$$M = a(1+r)^n$$

in which M = value of any nth gage number starting from the lowest; a = value in inches (in other unit) of lowest or smallest number, and r = the rate of increase from one gage number to another.

Now, assuming that the existing gage numbers have been graduated about according to trade demands, between No. 50 and No. 30 of the new British wire gage (which chances to start at No. 50 with 0.001 in. thickness) there is an increase of 12.4 fold in 20 numbers, which is equivalent to an increase of 13.4% from number to number. Computing this ideal series by the simple logarithmic process, and comparing it with the actual new British series and the proposed inch series, we have the following for the series between Nos. 50 and 41.

British wire gage numbers:									
50	49	48	47	46	45	44	43	42	41
Actual thickness of same, in thousandths of an inch:									
1.0	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4
Theoretical thickness for a constant increase ratio of 13.4%:									
1.0	1.13	1.29	1.46	1.66	1.9	2.1	2.4	2.7	3.1
Proposed new inch gage numbers:									
1	....	....	....	....	2	....	....	....	3

Here the actual series has considerably greater intervals than the theoretical one; in other words, the increase-ratio of present practice is not really constant between 50 and 30 but more rapid at the thin end, as is natural. Nevertheless, the B. W. G. provides seven unit numbers for thickness between 0.001 and 0.003 in. for which the proposed new gage will give only three. Continuing in the same way up to No. 30, we have:

40	39	38	37	36	35	34	33	32	31	30 (Nos.)
4.8	5.2	6.0	6.8	7.6	8.4	9.2	10.0	10.8	11.6	12.4 (Actual)
3.5	4.0	4.5	5.1	5.8	6.6	7.5	8.5	9.6	10.9	12.4 (Theoret.)
...	4	...	5	6	7	8	9	10	11	12 (New style)

This might be considered close enough, the graduation of new numbers from 4 to 12 being in fairly close proportion to that of long established trade custom. Still, in place of the existing 20 unit numbers between Nos. 30 and 50, we are reduced to 12, making it necessary to use fractions to give sufficient graduations for the thinner plates.

But as we rise higher in the scale our difficulty lies the other way. We now find that we have more numbers than there is any use for, or than it is reasonable to expect the trade to be prepared to furnish except by special order. Practical convenience will therefore require that there shall be a certain established convention as to what are supposed to be stock numbers, and what are mere interval numbers or sizes, not supposed to be used unless for some special reason. Assuming the ideal series to run in uniform ratio from No. 30 to No. 10 so as to strike No. 10 at the same thickness as the British gage it would compare as follows, the first line as before giving the number B. W. G., the second line the actual thickness in thousandths of an inch, the third line the theoretical thickness for a constant ratio, and the fourth line the numbers by the new gage.

30.	29.	28.	27.	26.	25.	24.	23.	22.	21.	20.
12.4	13.6	14.8	16.4	18.	20.	22.	24.	28.	32.	36.
12.4	13.9	15.7	17.6	20.	22.	25.	28.	32.	35.	40.
12.	14.	16.	18.	20.	22.	25.	28.	32. (Etc., as on next line above.)		

19.	18.	17.	16.	15.	14.	13.	12.	11.	10.	
40.	48.	56.	64.	72.	80.	92.	104.	116.	128.	
45.	50.	57.	64.	71.	80.	90.	100.	114.	128.	

Here we see that, far from being embarrassed by not having numbers enough to go round, we have greatly more numbers than we have any kind of use for, viz.: 128 − 12 = 114, for an interval of thickness for which trade custom only warrants using 20, and very reasonably and properly.

What are we going to do about it? What relief is to be offered to the puzzled manufacturer who finds orders raining in upon him from cranky customers whom he dislikes to disoblige, but who insist upon having No. "30," "35," "45," "50," "60," "70" and what not, as well as the thicknesses established by trade usage, which do not run at all on even fractions of an inch? There is but one possible thing to do; to establish a conventional scale of numbers which are supposed to be standard or stock numbers; in other words, to establish a new wire or sheet metal gage, in which the numbers run irregularly but bear a regular relation to the thickness instead of vice versa. Moreover, since the needs of different kinds of use of different metals or substances are different, this conventional gage could by no means be the same for all kinds of material, but would vary more or less for each.

In view of all this, is there not some room for the query "What's the use?" from disgusted manufacturers? Is it not, for example, more rational to adopt a gage for the different sheet metals which shall give a certain even weight per square foot? We are not answering our own question in the affirmative by asking it, nor are we throwing cold water on the proposal to adopt the inch scale for all kinds of gagings. We are simply pointing out the truth about it; showing that there will be decided losses as well as gains, and that to put the new proposal in shape for practical use and general acceptance vastly more work is needed than merely to "recommend" or "enact" it. It must first be put in shape to use without trade confusion and annoyance. To put the whole difficulty before us in its real dimensions, let us run up the scale as heretofore from No. 10 to and beyond Nos. 1 and "single 0" to the last absolute limit: "septuple 0." We then have the following:

No.	10.	9.	8.	7.	6.	5.	4.	3.	2.	1.
128.	144.	160.	176.	192.	212.	232.	252.	276.	300.	
128.	141.	154.	165.	185.	204.	223.	245.	269.	295.	
No.	0.	00.	000.	0000.	00000.	000000	0000000			
224.	348.	372.	400.	432.	464.	500.				
324.	356.	390.	428.	470.	515.	566.				

The first line, as before, gives the numbers B. W. G., the second line their actual thickness in thousandths of an inch, and the third line their theoretical value if graded to give a uniform increase (10.97%) between the actual No. 10 and the actual No. 0. This same ratio of increase is then assumed to extend up to "septuple 0," though as a matter of fact the gradations above No. 0 are a little finer than this.

Here we see that the new scale would afford 500 − 128 = 372 different numbers between thicknesses for which present trade custom assigns only 17 numbers; complained against by no one as insufficient.

In these facts we see the reasons why the use of these gages has been so persistently adhered to, despite half a century of ridicule. It is not half so great a "trade stupidity" as it seems to be on the surface. On the contrary that or something like it is a practical necessity for general convenience. It will be perfectly idle to attempt to displace it by any system which merely makes the "number" mean so many thousandths of an inch and goes no further. Yet to hear the mechanical engineers discuss the matter, one would have though that this obvious view had never occurred to any of them.

We hope that the committee appointed will not be so inconsiderate, but will report, if it reports favorably at all, a series of numbers which it recommends as standard. To judge from a few of the existing gages a series something like this might answer (and not more than answer) for all sheet metals and for wires:

Nos. 1, 1½, 2, 2½, 3, 3½, 4, 4½, 5	(9 nos.)
6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	(11 nos.)
18, 20, 22, 24, 26, 28, 30	(7 nos.)
35, 40, 45, 50, 55, 60, 65	(7 nos.)
70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200	(14 nos.)
210, 225, 250	(3 nos.)
275, 300, 325, 350, 375, 400, 425, 450, 475, 500	

This makes a total of 61 used numbers, where now there are about 57; and yet, to illustrate the inherent difficulty of the subject, the Birmingham gage for brass, silver and gold has 19 numbers between what would be the new No. 61 and No. 167, no one of which corresponds exactly with the nine numbers which, according to the above classification, seem to satisfy fairly well the sheet iron and wire demands.

Again to correspond to the Trenton Iron Co.'s gage for wire, we should need, in addition to those above listed, Nos. 7½, 8½, 9½, 17, 22½, 25, 31, 52½, etc., the numbers following the general scheme of somewhat arbitrary selection which we have followed above, but differing considerably in some of the units.

Again, to correspond to established custom in the tin-plate trade, we should need the following numbers by the new scale, those in parenthesis being the numbers not included in our above selections:

Mark.....	IC.	IX.	IXX.	IXXX.	IXXXX.
No.....	12	14	16	18	20
Mark.....	DC.	DX.	DXX.	DXXX.	DXXXX.
No.....	16	20	(25)	28	(32)

With sufficient patience and effort we do not doubt these difficulties can be overcome, and even if the only result of the movement should be to induce manufacturers to abandon all other numbers than those which designated the thickness in thousandths of an inch, leaving each man or each trade to pick out what numbers he or it would elect to use in practice, something would be gained. It would not be so very much, however, for the trade list would still have to be referred to before making out orders.

THE RELATIVE ECONOMY OF HIGH-DUTY PUMPING ENGINES.

The new pumping engine designed by Mr. E. D. Leavitt, for the Boston water-works, illustrated on our inset sheet and described in another column, is easily the most interesting machine of this class that has been built for a long time. We have elsewhere commented on its many novel details, the general aim of which is to secure the largest performance of work with the least consumption of steam. The use of high-duty engines is now becoming so general and there is such a tendency to call for higher duties, that it is worth while inquiring whether the gain from a given high-duty compensates for the increased cost of the engine which secures it. Of course no general answer to this question is possible which will exactly apply to any given case. The cost of coal and the rate of interest at which money can be borrowed are factors which vary between wide limits. The first cost of pumping engines of a given duty also varies widely with the location and responsibility of the purchaser and many other particulars. At the same time, by assuming certain values for these and other variables of most importance, as near an average as possible, we may gain an idea of the saving due to a high duty and the proportion it bears to the cost of obtaining it.

The pumping engines now on the market may be somewhat arbitrarily classified in four groups. We have first the common steam pumps, single cylinder or duplex, not compounded, and without condensers. The duties of such machines as well as their cost vary within such wide limits that it is difficult to fix on values which will be fairly representative; but it is perhaps fair to credit this type of engine with a duty of 40,000,000 ft.-lbs. This class of engine is seldom built nowadays of very large size. A capacity of 20,000,000 gallons daily ought to be obtained by the use of several machines at a cost of, say, $40,000.

The next class is composed of the familiar compound condensing duplex direct-acting engine, a type of machine which is probably in more extensive use for water-works service in this country than any other. We believe there are several builders of these engines who are willing to guarantee a duty of 70,000,000 ft.-lbs. for machines of this class, of large size, say 20,000,000 gallons capacity per 24 hours. The cost of an engine of this size and duty, we will assume at $55,000.

The next class of machines, that producing a duty of 100,000,000 ft.-lbs., we have introduced in the tables below more to show the economy of such duty than because such machines are extensively represented in the market. Still, we know of one builder of compound condensing duplex pumping engines who offers to build his machine with fly-wheel attached and to guarantee 100,000,000 ft.-lbs. duty. Another builder turns out an engine for which he will guarantee 90,000,000 ft.-lbs. duty and perhaps more when his designs have been thoroughly tested and perfected. Let us set the price on this class of machines at $80,000 for 20,000,000 gallons capacity.

In the fourth class we have such machines as the Holly-Gaskill and Worthington high-duty engines, doing on the average, perhaps 120,000,000 ft.-lbs., duty and costing some $100,000 for the size chosen for comparison.

Finally, we have the Boston engine elsewhere described, costing about $145,000, and producing a duty, let us assume, of 140,000,000 ft.-lbs.

Then arranging all these figures in tabulated form and comparing each engine with that of the next lowest duty we have:

Duty of engine Million ft.-lbs. per 100 lbs. coal.	First cost of engine of 20,000,000 galls cap.	Additional duty above engine of next lowest duty Million ft.-lbs.	Additional cost above engine of next lowest cost.
40	$40,000	..	.....
70	55,000	30	$15,000
100	80,000	30	25,000
120	100,000	20	20,000
140	145,000	20	45,000

Let us next compute the saving due to the higher duty. The variables here are the amount of work done by the engine and the price of coal. Let us assume that the total amount of work performed by the engine equals what it could do if it worked at its full capacity for three-fourths of the time and against a head of say 150 ft., and take the price of coal at $3 per ton.

On this basis a 20,000,000-gallon engine will perform in a year: $20{,}000{,}000 \times \frac{3}{4} \times 8.36 \times 150 \times 365 = 6{,}865{,}650{,}000{,}000$ ft.-lbs. of work. The annual fuel consumption for each engine is then obtained by dividing this quantity by the engine's duty. Thus we have:

Duty of engine (1 = 1,000,000)...	40	70	100	120	140
Tons coal per annum.... 8,582	4,904	3,432	2,860	2,452	
Tons coal saved compared with engine of next lower duty.....	3,678	1,472	572	408	
Money saved at $3 per ton..... ....$11,034	$4,416	$1,716	$1,224		

The investment necessary to secure this saving for each class of engine was shown in the preceding table. The interest charge on this investment may fairly be taken at 4%, since almost any city which is large enough to require a pumping engine of such a size and which has a good financial reputation can float 4% bonds at par. Of course Boston, New York, Philadelphia and other large cities in the East can borrow money at 3% or less. Concerning depreciation, the life of a well built pumping engine of any of the types we are considering is certainly not less than 30 years. The saving per annum necessary to amount at compound interest to one dollar at the end of 30 years is 2.1 cts. Hence 2.1% is the annual charge for depreciation, and the total charge for interest and depreciation on the original investment may be taken at 6.1%. At this rate the "fixed charge" on the investment in each engine above that required for the engine of next lower duty, and the annual return from this investment compare as follows:

Engine duty, millions of ft.-lbs.	Int. and dep. at 6.1% on additional cost above engine of next lower duty.	Annual saving in coal bill compared with engine of next lower duty.	Annual profit from gain in duty.
70	$915	$11,034	$10,119
100	1,525	4,416	2,891
120	1,220	1,716	496
140	2,745	1,224	−1,521

The most important fact which is shown by the above table is that the profit from increasing the duty of a pumping engine falls off very rapidly as the duty rises. The main reason for this is obvious enough. Much more is gained by saving a quarter of the coal used by a very wasteful engine than by saving the same proportion of that used by a very economical one of the same capacity. Even with cheap coal and high rates of interest the city which operates pumping engines of only 40,000,000 ft.-lbs. duty would seem to be pursuing a penny wise and pound foolish policy. When a duty of some 70,000,000 ft.-lbs. is attained, however, it is quite possible that an increase in the duty may cost more than will be gained through the saving in fuel, and with each increase in the duty the possible gain from a further increase is diminished. It was a great achievement in mechanical engineering to raise the duty of a pumping engine from 100,000,000 ft.-lbs. to 120,000,000 or more; but in considering commercial results from a pumping plant of a given size it is of far less importance than the increase from 40,000,000 to 70,000,000.

Of course the conditions vary so widely that only general conclusions can be drawn from the table above. In the purchase of pumping machinery it is the first duty of the purchaser's engineer to determine approximately what duty is the most economical, and to state this in his request for bids from manufacturers. Of course it cannot be known exactly what duty will result in the greatest economy until the price of engines of various duties is known; and bidders should always be asked to state what duty they are willing to guarantee for their machines. It can then be determined what engine is the most economical for the city to purchase, so far as the factors of first cost and fuel economy are concerned.

In making such computations for a given case, many factors may be taken into consideration which have been neglected in our general discussion above. The price of fuel may be taken, for example, not at its present market price but at what it is likely to average during the life of the engine, if reason exists for expecting higher or lower prices to prevail. The cost of handling the additional fuel used by a lower-duty engine and the disposal of its ash, the interest, depreciation and repairs on additional boilers and larger boiler house, extra attendance or oil consumption, and extra repairs of one engine compared with another,—these are among the factors which should be weighed in deciding on the most economical duty for a pumping engine in a given location.

As an example of how local circumstances may alter the conditions, we may take the case of the Boston engine. It does not follow from the table above that this engine will be a less economical investment for the city than could have been made. As Boston can easily borrow money at 3% or less and as the life of the Leavitt engine may certainly be taken as at least 40 years, we have a total interest and depreciation charge of 4.3%. On the other hand, coal at the Chestnut Hill station where this engine is to be placed, cost last year $4.90 per ton. Remembering that the price of coal is probably destined to a steady increase in this country, as in Great Britain, it seems fair to take a sum of $6 per ton as representing the average cost, with the cost of handling ashes, and charges for the extra boiler capacity required. On this basis the interest and depreciation charge on the added cost above that of a 120,000,000-duty engine becomes $1,935. The 408 tons of coal annually saved by the higher-duty engine amounts at $6 to $2,448, leaving a profit of $513 per annum in favor of the higher-duty engine.

Whether the engine proves the most profitable which the city could have purchased or not, it is fortunate that an engine of such novelty in construction, which gives an opportunity for testing the value of several departures from ordinary practice, is being constructed. Notwithstanding the meritorious work done by the leading firms building pumping engines, there is some tendency under our modern conditions of machine construction to adhere to established standards and precedents and neglect new ideas. It is well that engineers of Mr. Leavitt's ability still have some opportunity to put their ideas into practical use and lead the way to greater perfection than has yet been attained.

We have shown above that for a machine of a given size, a certain increase in its efficiency results in far greater saving when it is working with great wastefulness than when it is already so improved that it works with a high economy. But it does not follow from this that in the broad view an increase in the duty of pumping engines from 120,000,000 ft.-lbs. to 140,000,000 would be less important commercially than was the improvement from 50,000,000 ft.-lbs. to 70,000,000 ft.-lbs. Cities have doubled, tripled and quadrupled their water supplies during the last 30 years, and the end is not yet. The enormous amount of power used in these days makes a small increase in its economical generation quite as important as an equal increase was in the days when far greater room for improvement existed.

The above editorial was put in type some weeks ago and proofs were sent to the principal builders of pumping engines and to other parties interested, inviting such criticisms or comments as they chose to make. We have received in response a number of very interesting letters which we reprint in our correspondence column.

We have made no changes in the editorial from the form in which it was submitted for criticism, in order that the letters as published, might lose none of their pertinence; and in order that the reader might weigh for himself the importance of the various criticisms. It is probable, however, from the information contained in these letters, that an all-around reduction of 10 to 20% in the prices assumed above for the several classes of engines would make them better representative of present market prices. Beside this, as several of our correspondents point out, a considerable portion of the increase of cost with the increase of duty is for better material and workmanship, which is required to obtain longer life, less expenses for repairs, and maintenance of the original duty record after many years of work. It is well pointed out, too, by one engineer of high rank, that every gain in duty is not necessarily accompanied by an increase in first cost. Broadly speaking a high duty engine costs more than one of lower duty; and it was merely a general comparison between this increase of cost and the returns obtained from it, considered as an investment, which was intended in the above comparison.

The criticism that it is the average duty which is attained in an engine's life and not the original duty obtained on a contract test which should be considered in computing the economy is a very proper one; but the contract duty was assumed in our comparison because the duty attained by engines in years of service is something very difficult to ascertain with sufficient accuracy for comparative purposes. Average yearly duties being computed on fuel burned, all the difference in quality of coal, economy of boilers and efficiency of engineers and firemen operates to hide or exaggerate the differences between the economies of different engines.

We shall be pleased to give space to further communications on this subject, and reserve further comments upon it until such further discussions are published.

LETTERS TO THE EDITOR.

THE RELATIVE ECONOMY OF HIGH DUTY PUMPING ENGINES.

Sir: Your proof sheets of article on the Boston high duty pumping engines were duly received. . . . . I am glad to see that you go into the question of the return on the investment, as this is something which is nearly always neglected in the choice of a pumping engine, with the result that in nine cases out of ten the purchaser chooses the worst paying engine offered him. There is one factor which you mention, but which I think should be strongly emphasized, and that is the cost of repairs. A good deal of money can be put into an engine in the first place which will save a good deal more money in subsequent repairs. The large cost of the Boston engine does not all go to obtain a high duty, as the same test duty could be obtained with a very much cheaper engine: but a large part of it goes for substantial construction, perfect fits, conveniences for adjustment and superior materials: For instance: All small non-adjustable joints in valve gear, etc., are made with hardened steel pins, working in hardened tool-steel bushings; the pins being ground on dead centers and the bushings being lapped cut to a perfect fit. These are much more expensive than pins cut from cold rolled iron, working in bushings cut from brass tubing, but they wear for years without lost motion. All adjustable parts, such as main pedestals, connecting-rod ends, etc., are so made that the adjustments can be effected in a moment, without the necessity of filing down brasses or distance pieces or taking out liners, so that it is the easiest sort of a matter to keep the engine in perfect alinement. Every continuously moving part is automatically lubricated, and a thousand and one refinements are provided with a view to the long life of the engine and small expense of repairs and attendance, irrespective of the duty.

But the great factor to be considered is the ability of an engine to keep up its duty, and comparisons of return on investments should be made on the duty which the engine will perform IN SERVICE and not on test. This factor can only be determined by referring to what engines of the same design, or by the same designer or builder, have previously done. Some engines can keep up to their test duty year in and year out for a long time, while others fall sadly behind in a few years, if not in a few months. I do not wish to specify any given engine as a bad example, but if you will compare the test duties of various engines with their running duties you will find that some engines with records for phenomenal test duties are not doing so well in actual work as others which were more modest in their contract requirements. The Lynn engine, when tested in 1873, gave a duty of 103,923,215 ft.-lbs., and now after constant service for over 18 years it exceeds that duty year in and year out. The Lawrence engine gave a duty

of 96,186,979 ft.-lbs. in 1876, and last year gave a duty of 106,908,652 ft.-lbs. for the whole year.

A very good example of a well built engine of the old school, giving a better duty after a great many years of service than some engines of more modern and pretentious design, is the old McAlpine engine at New Bedford. This is a non-compound engine built by the Quintard Iron Works about 1868, in fact before the days of compound pumping engines in this country. Its duty last year was 68,410,278 ft.-lbs. per 100 lbs. of coal, including coal used for starting fires and banking, without any deduction, which is a much higher regular duty than is given by ANY compound condensing engine of the duplex type (not including the "high duty" type). The highest regular duty of any engine of this class that I know of is that at the Mystic pumping station, Boston water-works; its duty for last year was 58,380,500 ft.-lbs., while the average daily duty of this type is probably less than 50,000,000. There is, alongside of the McAlpine engine at New Bedford, a compound duplex high duty engine which last year developed a duty of 76,375,766 on the same basis; or, taking the duty on the basis of combustible used while pumping, the McAlpine duty was 86,094,002, and that of the compound duplex high duty engine was 91,444,619; or only about 6% better for a compound engine 6 years old than for a simple engine 23 years old, both being under the same most careful management. Examples could be cited ad infinitum, but I think that my meaning will be made clear by the above illustrations. The question of the commercial duty of various types and makes of engines can easily be solved by compiling the reports of various water-works, but it is much to be regretted that many water boards do not publish such reports as one could wish for.

Very truly yours, Asa M. Mattice,
Supt. for E. D. Leavitt.

Cambridgeport, Mass., Nov. 16, 1892.

Sir: I have looked over the matter which you have prepared, with considerable interest. You have classed the merchantable engines in your groups with duties of 40, 70, 100 and 120 million ft.-lbs., and have classed the Boston Leavitt engine as of 140 million ft.-lbs. duty. This classification does not seem to me to be correct, since the Leavitt engine will do a yearly duty in actual service of not less than 140,000,000 ft.-lbs. per 100 lbs. of coal; and, so far as my investigations have gone, I fail to find actual yearly duties which correspond with the classification you have made. For example, there are at the Boston Chestnut Hill pumping station two 8,000,000-gallon Gaskill engines (your class 4); their duty for the year 1891 was 101,380,800 ft.-lbs. per 100 lbs. of coal, with an actual boiler evaporation of 10.34 lbs. of water per lb. of coal. At the Boston Mystic pumping station the engines are of the compound condensing Worthington duplex type (your class 2), and their duty for the year 1891 was 58,380,500 ft.-lbs. per 100 lbs. of coal.

The report of the Department of Public Works of Chicago gives for the year 1890 a duty of 71,607,000 ft.-lbs. for the 12,000,000-gallon Gaskill pumping engines at the North Side pumping station (your class No. 4).

The report of the Water Board of New Bedford gives for the year 1890 a duty of 80,022,754 ft.-lbs. for their high-duty Worthington engine (your class No. 4).

I have been unable to find any water-works reports which give yearly duties exceeding those obtained in Boston for similar types of engines (your classes 2 and 4), and, therefore, believe that your comparison of comparative economy should be based upon the results actually obtained by the Boston Water-Works; since under similar conditions the new Boston Leavitt engine is designed to give a yearly duty of at least 140 million ft.-lbs. Also in any comparison of the values of different types of engines, the boiler capacity required, the life of the machine and the yearly cost of repairs must be taken into account.

A large proportion of the excess of cost of the Leavitt engine over that of the other types mentioned is due to special construction, to the extra sizes of the different parts, and to the use of more expensive materials than is usual in merchantable engines, for the purpose of prolonging the life of the machine and of reducing to a minimum the yearly cost of repairs.

Yours very truly,
William Jackson, City Engineer.

Boston, Mass., Nov. 21, 1892.

Sir: It seems to me that in estimating the cost of the various types of machinery, you have taken too high a cost for the 140,000,000 ft.-lbs. duty machine; that is, $145,000. While it may be true that the cost of the new Boston engine is to be $145,000, it does not necessarily represent the cost of a 20,000,000-gallon engine capable of giving a duty of 140,000,000 ft.-lbs. for each 100 lbs. of coal burned.

There are in the city of Chicago five triple expansion pumping engines, each having a capacity of 18,000,000 gallons in 24 hours against a head of 125 ft. Two of these engines which have been already tested gave a duty as high as 140,416,679 ft.-lbs., the duty being based on an evaporation of 10 lbs. of water per lb. of coal. The steam consumption per horse power for the Chicago engines was 12.675, which I believe is lower than any previous record.

The cost of these engines, including boilers and steam and water piping in the building, was only $74,000 each. There is in the city of Milwaukee a triple expansion pumping engine whhich has given a duty of about 127,000,000 ft.-lbs., with an evaporation of only 8.76 lbs. of water per lb. of coal, which would be equivalent to 145,000,000 ft.-lbs. on a 10-lb. basis. The steam consumption per indicated horse power of this engine was 12.155 lbs., which is lower than any published record of steam consumption per horse power for any engine of any type, as far as I am aware. This engine cost, together with its boilers, $76,000, and is an engine developing about as much power as will be required of the Boston engine.

There is now building for the city of Detroit, Mich., a triple expansion engine having a capacity of 24,000,000 gallons in 24 hours, against a head of 135 ft., with a guaranteed duty of 130,000,000 ft.-lbs. on a 24-hour test (and it is expected to obtain 140,000,000 duty), or 120,000,000 ft.-lbs. on a 30-day test, based on all coal burned during the test without deductions of any kind. The cost of this engine is $90,000, including the foundation and four boilers set complete.

All of the above duties have been obtained with a steam pressure not exceeding 125 lbs. per sq. in., while if the steam pressure were increased to the point where it will be carried on the Boston engine, a very material increase in economy would result without increase in cost of machine. The builders of these engines would be perfectly willing to b uild a 20,000,000-gallon triple expansion engine to work against 150-ft. head, for $100,000, including boilers, erected in any city east of the Mississippi River; and with 100 lbs. of steam would guarantee a duty of not less than 140,000,000 ft.-lbs. for each 1,000 lbs. of steam consumed by the engine for all purposes, without deduction or allowance of any kind. They have obtained as high as 128,000,000 ft.-lbs. duty with a triple expansion engine, with 80 lbs. boiler pressure.

With regard to the relative cost of compound and triple expansion engines, it is of course largely a matter of the design of the machines, some types of compound engines costing fully as much as another type of triple expansion engine. However, taking two engines of the same relative design, the cost of the triple expansion will not exceed that of the compound more than from 25% to 30%, and taking 120,000,000 ft.-lbs. duty as about the highest obtainable with a compound engine, a triple expansion with the same relative efficiency would give 140,000,000 ft.-lbs. duty.

After having once decided to pass the 120,000,000 mark, it is no more expensive to obtain above 130,000,000 ft.-lbs. duty, if the machine is properly designed, than it is to obtain less; and as pumps having three cranks give the best effect on the water mains, etc., it is as easy to build them triple expansion as to build them compound, with one high pressure and two low pressure cylinders or similar arrangement. Yours truly.

* * *

Sir: Our criticisms are that the price which you have named for Holly-Gaskill high-duty engine ($100,000) is too great for a machine of that kind and capacity against a head of 150 ft., as we would be willing to furnish one for $80,000. If the head were 200 or 225 ft., $100,000 would be about right. We inclose some notes made by one of our engineers which were prompted by this difference in price.

As to the cost of other engines mentioned, we have no remarks to make, but think your article timely, interesting and valuable. Yours respectfully,

Holly Manufacturing Co., by C. G. Hildreth, Secy.

Lockport, N. Y., Nov. 16, 1892.

The note inclosed was as follows:

The annual profit from gain in duty of the engine costing $80,000 and of 120,000,000 ft.-lbs. duty above the next lower, is equal to the annual saving of coal, as compared with engine of next lower duty, or $1,716. For the engine costing $145,000, and developing a duty of 140,000,000 ft.-lbs., the interest and depreciation at 6.1% on additional cost above that of engine of next lower duty equals $3,965, and the annual saving in coal as compared with engine of next lower duty is $1,224, leaving an annual loss of $2,740.

In the case of Boston, with the price of coal at $6 per ton, and interest and depreciation taken at 4.3% on increased cost of Leavitt engine above that of the next lower duty ($80,000 and 120,000,000 duty), the actual loss of the Leavitt amounts to $1,571 annually.

Sir: We are obliged to you for the opportunity for reading the advance proof of the article on high duty pumping engines. We note that the figures are all based on the largest machines, which, of course, from their size, show the greatest saving as against machines of less efficiency. The various duties quoted by you are the test duties, which are not maintained in annual runs. The writer's attention has been called to-day to a machine where probably as high as 110,000,000 ft.-lbs. duty was guaranteed, while the average duty during two years was 73,000,000 for one and 80,000,000 for the other. The prices named by you we suppose to represent the cost of the whole plant of pumping machinery in each case.

With regard to the life of the machines, we think the thirty years assigned by you is rather long. Of course it is possible to keep any of the machines described in running order almost indefinitely, but before the lapse of 30 years the chances are that any of them would be displaced by other machinery. With regard to the cost of coal, there would seem to be as much reason for expecting a depreciation in the price in this country as an appreciation during the next generation. The depreciation of plant does not seem to us, as you have figured it, to be correct. The usual course is for a city to borrow the cost of a pump and pay for it, paying interest on bonds representing this loan certainly during the life of the pump and possibly for a longer period. There is no sum set at compound interest to cover this; and the fairer way, and the one usually adopted, is to divide the cost of the pump into the number of years of its probable life.

We all see with pleasure that the "Leavitt" engine is to be built for the Boston high service. It may be said fairly to be an engineer's engine. The commercial engine does, as you state, remain somewhat the same from year to year in construction, as the standard machines are more readily sold. In fact, there is often a clause in a specification that no engine will be acceptable except a duplicate of one which can be seen in actual operation.

With these explanations we would offer figures, perhaps more nearly such as would be met with in practice, for your consideration. We would select the four engines showing a nominal duty of 70, 100, 120 and 140 millions. It is safe to say that in actual use these duties will fall off 15%. The highest ones, by the way, usually show the greatest percentage. Consider that these engines are to run three-quarters of the time and that the coal will cost $3, as per your estimate. Take the cost of the pumping plants at $55,000, $80,000, $100,000 and $145,000 respectively, and consider the repairs to average ½% per annum for the lowest duty machine, 1% for the two next and 2% for the highest duty machine. We do not think this estimate is high enough, averaging all the years of the life of the machine, especially as the more complicated ones are liable, in fact, almost certain, to meet with breakages, the repairing of which will cost considerable sums. We have figured the interest at 4%, the same as you estimate, and in the matter of help to operate the machinery, we have charged the lowest duty machine with two hands at a total annual cost of $2,000. The next two machines with three hands at $2,800 each machine, and the highest duty machine with four hands at a cost of $3,600. If any one of these machines can be operated with one less hand, all the others can. The necessary oil (cylinder and machinery), together with $50 for other supplies, would make a charge of $122 for the lowest duty machine, $312 for the next two, and we estimate the necessary supplies for the highest duty machine at $500.

The annual charges based on the above figures would stand against the first machine at $19,885; against the second machine, $17,703; against the third machine, $17,283; and against the high duty machine, $20,444. These annual expenses for the thirty years, with the original cost of the machine added in each case, would make the charge against the first machine at the end of thirty years $651,550, against the second machine, $611,000, against the third machine, $618,490, and against the highest duty machine, $758,320. If these machines were run one-half time—say 12 hours per day—and the figures were based on the same data, the result would be for the first engine $498,670; for the second engine, $509,180; for the third engine, $526,780, and for the fourth engine, $681,880. Of course these figures are changed materially by a change in the price of coal; cheaper coal, which can be had in many localities in this country, making the showing against the higher duty machine very much greater, while more expensive coal makes the change in the other direction. We believe it is a fact that the results obtained in actual practice with high duty machinery are in a large majority of cases disappointing. The figures given above indicate fairly well why this is so.

Yours truly, * * * * *

Sir: Yours on the comparative value of pumping engines, came to hand this morning, and I have read it with much interest. The various questions that would naturally arise in making a selection of a pumping engine, that in all respects would be to the best interest of the purchaser, have been gone over in a general way, and, perhaps, as fairly as is necessary in order to obtain comparative values, and I have no criticisms to make except to say that you placed the duty of the "common steam pumps, single cylinder or

duplex, not compounded, and without condenser," very much above what they will average, as 20,000,000 ft.-lbs. would be nearer the results ordinarily obtained. However, as this class of pumps cut no particular figure in connection with water-works engines for supplying cities, it may not be worth while to revise your figures so far as they relate to that part of the subject. Yours truly, • • • •

Sir: The only suggestion we have to make is that it is our opinion that a fifth column should be added, showing the difference in the skilled help required to care for and operate engines of the several classes mentioned. We suggest that the column should be made up somewhat as follows:

Duty of engine.	Engineers.	Greasers.	Total daily wages.
70,000,000.....	3 at $3	3 at $1.50	$13.50
100,000,000.....	3 at 4	3 at 1.50	16.50
120,000,000.....	3 at 5	3 at 2.00	21.00
140,000,000.....	3 at 6	3 at 2.50	25.50

The aggregate is shown in the last column to the right. Allowing eight-hour watches, which is common in most cities, the difference between the care of the 70,000,000 and the 140,000,000 engine is $4,380, while the estimated saving is only $2,152.

Yours very truly, • • • • • • •

Sir: Your advance proof carefully noted. Your comparison of costs, running expenses and benefits to be derived is, we think, very correct. This is an article that will be highly appreciated, and should do much good. Hughes Steam Pump Co.

Cleveland, O., Nov. 18, 1892.

THE DAIMLER PETROLEUM MOTOR.

Sir: In regard to the article on the Daimler petroleum motor in your issue of Nov. 24, it may interest you to know that the Daimler motor is being exploited on your side by the Daimler Motor Co. of America, Steinway Ave., Long Island City, and 111 E. 14th St., New York. Yours truly, Simms & Co.

40 Leadenhall St., London, Dec. 8, 1892.

CHURCHILL RAIL JOINT; NORFOLK & WESTERN R. R.

Sir: In looking over the article in Engineering News of Dec. 8, I note a few typographical errors. The joints are made by the Diamond State Iron Co., Wilmington, Del. The article stated: "A recent report shows the actual cost of labor maintaining the new joints is less than 50% of the cost of maintaining angle bar joints laid on the same section of the road." This should read "less than 30%."

It might be well for me to add by way of explanation that this 30% is practically all made up in labor tightening bolts. When these joints were put in 2½ years ago they were well put up on stone ballast and scarcely any of the joints have been tamped up since, notwithstanding the fact that there is a heavy traffic over this piece of track. This track is in good condition, far better than the adjacent section equipped with angle bars on which a very considerable amount of labor has been expended. Yours truly,

Chas. S. Churchill,
Engr. Maint. of Way, N. & W. R. R.

Roanoke, Va., Dec. 13, 1892.

ROLLING RAILS AND REHEATING.

Sir: Is there any steel rail mill in the United States or anywhere else, which makes steel rails by a continuous process from the ore to the finished rail, without reheating the metal before rolling out rails?"

Subscriber.

New York, Dec. 2, 1892.

(There is not a mill in the world which produces rails as our correspondent suggests by his question. In all cases the ingot has to be reheated after it is cast and before rolling or hammering it. The liquid steel must be given time to solidify. The universal practice is to utilize the heat of the cast ingot either in a gas or coal fired furnace of some form, and this is done in some cases in Europe in soaking pits, the walls of which have been highly heated from the radiated heat of previous hot ingots which have been charged in them. The heat of the walls is sufficient to permit the subsequently charged ingots to equalize their interior and exterior heat while the metal of which they are composed is solidifying. These plain soaking pits without fire have been tried in this country, but not adopted.

The old practice was to permit the ingot to get absolutely cold, before charging into heating furnaces of any kind. Later, the practice was to save the "casting" heat; then roll into a bloom; let that cool; cold-chip out any defects; then reheat and roll into rails. Still later, the practice was to hot-chip out these defects if any, charge while hot into reheating furnaces and roll into rails.

The latest practice is to roll direct from the heated ingot into rails. This is now done at the South Works, Scranton, Pa., Sparrow's Point (Maryland Steel Co.), Edgar Thomson, Illinois Steel Co.'s Joliet, Union and South Works. The Old Mill at Scranton, Pa., the Bethlehem, Pennsylvania Steel Co. and Cambria works, reheat the blooms.—Ed.)

HIGH SPEED LOCOMOTIVES.

Sir: I have carefully read your article on high speeds in your issue of Dec. 8, and am pleased to say that in my opinion it is the most able article yet written on this all absorbing subject. You have solved the secret of the problem of attaining high speeds. It is in the use of the piston valve, which works freely and equally as well at 200 lbs. as at lower pressures. The old slide valve is not to be considered at all. You are aware that the engines of our ocean greyhounds, such as the "City of Paris," are fitted with valves of this description and could not make the revolutions they do had a large slide valve to be operated.

All our compound engines are fitted up to operate at 200 lbs. steam pressure, and it is only the natural timidity of the railroad men that prevents the adoption of this pressure. We have several locomotives in service now using 200 lbs. pressure, and the owners will not think of employing less. The Chicago, Milwaukee & St. Paul R. R. discovered the inability to operate slide valve engines at this pressure, whereas the compound engine, with piston valves, was in her element at that pressure. The compound locomotives built for the Pikes Peak (Abt rack rail system), Rio Grande R. R., and several others are working and giving no trouble at this pressure. Long port openings, economy of steam, and frictionless parts are the essentials to 100 miles per hour, and I will soon be there.

Yours truly, S. M. Vauclain,
Superintendent, Baldwin Locomotive Works.

Philadelphia, Pa., Dec. 14, 1892.

(We have referred to Mr. Vauclain's letter in our editorial columns.—Ed.)

THE FLOW OF WATER OVER WIDE-TOPPED DAMS.

Sir: In your issue of Sept. 29 you call attention to a demonstration on the flow of water over a wide topped dam by Mr. J. P. Frizell, as if it were both doubtful and new. I therefore venture to refer you to the article on "Hydromechanics" in the "Encyclopedia Brittannica" (p. 472 of the ninth edition), in which you will find the same result demonstrated, and, as this work is not within the reach of every one, I take the liberty of enclosing a copy of the paragraph for your perusal, and would suggest your reprinting it, as the form in which the demonstration is given appears to me slightly more conclusive than that adopted by Mr. Frizell, though the principle and result are identical with his.

The article quoted is by Prof. Cawthorn Unwin, then of Coopers Hill College; and, as one of his old pupils, I trust I may be pardoned for recommending it to your notice as by far the best and most concise treatise on the subject known to me. It has, I believe, been reprinted in England separately for use as a text book.

Yours truly, C. W. Hodson,
Engr. in Chief, N. W. Ry.

Quetta, Baluchistan, Nov. 7, 1892.

(As our correspondent will have seen by later issues we have already examined and quoted from this admirable article. Our correspondent is not quite correct in stating that it gives "the same" result, there being a fractional difference which

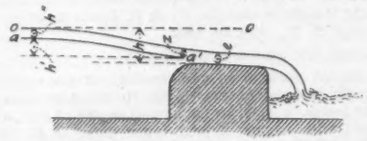


Fig. 50.

has since been the subject of dispute. In fact, Mr. Frizell's motive in giving this demonstration was to refute materially different allegations given in an earlier issue in regard to some works of his design. As Professor Unwin's demonstration is certainly very neat, however, and as the subject has excited some general interest, we give it below.—Ed.)

(Extract from article on Hydromechanics by Prof. C. Unwin in "Encyclopedia Britannica.")

40. Weir with a Broad Sloping Crest.—Suppose a weir formed with a broad crest so sloped that the streams flowing over it have a movement sensibly rectilinear and uniform (Fig. 50).

Let the inner edge be so rounded as to prevent a crest contraction. Consider a filament aa', the point a being so far back from the weir that the velocity of approach is negligible. Let OO be this surface level in the reservoir, and let a be at a height h'' below OO, and h' above a'. Let h be the distance from OO to the weir crest and e the thickness of the stream upon it. Neglecting atmospheric pressure, which has no influence, the pressure at a is Gh''; at a' it is Gz. If v be the velocity at a',

$$\frac{v^2}{2g} = h' + h'' - z = h - e;$$

$$Q = b\,e\,\sqrt{2g\,(h-e)},$$

Theory does not furnish a value for e, but $Q = 0$ for $e = 0$ and for $e = h$. Q has therefore a maximum for a value of e between 0 and h, obtained by equating $\frac{dQ}{de}$ to zero. This gives $e = \frac{2}{3}\,h$, and, inserting this value,

$$Q = 0.385\,b\,h\,\sqrt{2g\,h},$$

as a maximum value of the discharge with the conditions assigned. Experiment shows that the actual discharge is very approximately equal to the maximum, and the formulæ is more legitimately applicable to the discharge over broad-crested weirs and to cases such as the discharge with free upper surface through large masonry sluice openings than the ordinary weir formula for sharp edged weirs. It should be remembered, however, that the friction on the sides and crest of the weir has been neglected, and that this tends to reduce a little the discharge. The formula is equivalent to the ordinary weir formula with $c = 0.577$.

THE PELTON WATER WHEEL AND ATKINS' TURBINE PATENT.

Sir: One of your contemporaries having published a letter written by R. D. O. Smith, concerning the Pelton water wheel, accusing it of being a plagiarism, you give an abstract of this statement in your issue of Aug. 11, last, and thereby impart an importance to the letter that otherwise it would not have. It is apt to mislead, and should not remain uncontradicted.

Mr. Smith states as follows:

1. The reason for its (the Pelton wheel) efficiency has never been explained.

2. The principle involved has a curious history. It was embodied in a turbine invented by Jearum Atkins.

3. The Pelton wheel, "if more perfectly formed," would realize the full theoretical value of the jet.

In justice to a mechanism so generally acknowledged as of superior efficiency and of more easy adoption than most other contrivances offered for the utilization of water gravitation, will you permit me to controvert these three points in the order named.

1. The pamphlet of the Pelton Water-Wheel Co. contains on page 4 the following:

"The manner of utilizing this pressure (afforded by a head of water) is its distinguishing feature, and the secret of its extraordinary energy. As indicated in the illustration herein, the buckets on the periphery of the wheel are of a peculiar shape, with a wedge in the

The Atkins Turbine.

center, which divides the stream in such a way as to develop its full force, while in passing out it sweeps against the curved sides with a reactionary influence, giving it the effect of a prolonged impact. It is also by this means deflected from the course of the wheel, so as to offer no resistance to its motion. That the power of the water is fully exhausted is shown by the fact, that it falls from the buckets perfectly inert, no water being carried over; nothing but a mist above and a little stream below to indicate the gigantic force that has been so quietly liberated."

In these words, referring to a small Pelton wheel running under great head pressure, the main reason for its efficiency is plainly stated.

2. There is, indeed, some "curious history" about the principles involved in the Pelton wheel, although in quite a different sense from what Mr. Smith evidently desired to convey.

The Atkins' patent describes a horizontal turbine "designed to be placed within the flume; to be entirely submerged," or "with very slight changes" "outside of the flume, in which case the cap, which overlaps the wheel might be dispensed with." He designs it to be used with a "trunk, by which water is supplied to the wheel," having "the form of a double scroll, having two chutes, each of which extends half way round the

wheel." What an audacious imagination does it take to find in this turbine, to be placed within a flume and receiving water on its entire circumference, the same principle involved as in a wheel such as the Pelton, which, "when placed within a flume" would be as motionless as a dead mouse, and which, when set in motion, receives water either by a single jet at a single point of its circumference, or at all events by a limited number of jets, and on a fraction of its circumference only.

The Atkins' specification speaks of "an improved mode of constructing the buckets and securing them to the wheel," which it is needless to describe in detail, but which is entirely different from the Pelton. Each pair of buckets leaves between them a "channel," of uniform width on its entire length, and of semicircular form, the water entering in a tangential direction at one end of the semicircular channel on the outside circumference of the wheel and passing through the semicircular channel (formed by two successive buckets), to an inner circle of the wheel, and by such inner circle to the ditch below. And, as a condition to the efficiency of the turbine, the patentee states, that the aggregate sectional area of all of these channels should be equal to twice the aggregate sectional area of the two chutes in the trunks because "on allowing the wheel to run with its maximum speed of half that of the water, the velocity of the water in its passage through the buckets will be only half what it was, while the wheel remains stationary.

It appears from the entire specification, that, Atkins had not the slightest idea of increasing the percentage of energy to be developed by his turbine by causing the jets to squarely strike any one bucket as such after the other, as in the case of the Pelton, while all his ideas clustered around the form and area he would give to the water channels left between the successive buckets; which latter, for such purposes, he made semi-cylindrical, the back of each being elongated so as to extend into the face of the next one to it, "so as to form semicircular channels."

It therefore appears that the principle involved in the Atkins' turbine is one relating to the aggregate area and semicircular form of the water channels receiving water on the entire circumference of the wheel, the form of bucket being incidental only to the form of channel.

But, assuming for a moment Mr. Atkins had laid claim, which he certainly did not, to a bucket independent and isolated in action, though placed in a series on a water-wheel, not even then could it be truly stated that his bucket represents the principle involved in the Pelton wheel, because the Pelton wheel has indeed not the semicircular buckets of the old and often rejected, less effective shape, but has buckets with a double concavity, diverting the water, but not before it has imparted to the wheel the full force of its pressure, in two divided halves, entirely away from the body of the wheel and not to its central area. But had Mr. A. raised such a claim to a bucket convex on its back, face and concave (semicircular), on its front face, he would only have claimed what long before the date of his application was public property, and a part of what the manuals of theoretical mechanics and hydraulics contained.

I have before me a manual of theoretical mechanics in its fifth edition, printed in 1874 and 1875. (Mr. A.'s patent is dated 1875, and it run out on Aug. 10 last), in which on page 158, the following occurs:

"The effect of the water jet is increased when striking a concave face."

It is true that Mr. A. missed this increased effect by causing the water to strike the concave face on a tangental line to its own circle, and to enter the channel left between two buckets, in the direction of the channel itself, thus causing the entire jet to be diverted toward the wheel's center without striking the resisting face squarely and effectively with its full force.

In the Pelton wheel and bucket all this is different. The water jet strikes the resisting face on the tangential line of the entire wheel squarely in the direction of its receding motion, and with its full force, and though it is divided it is not diverted from its effective direction, until after the blow has been squarely struck, when the divided stream, after losing velocity and force is diverted so as not to impede continuous action. The wedge is the correct materialization of a correct scientific theorem, but not a mistaken application thereof.

The curious part of the history of a correct principle of general theoretical mechanics and hydraulics, which can be claimed by no one as his invention, is found in this, that Mr. A. in an attempt to make practical use of it, was misled by his own faulty perception of the principle into making an erroneous or faulty application thereof, and that Pelton was the first to make real, practical, well directed use of a known theory.

3. Mr. S. cannot possibly be in earnest, if he would claim that any mechanical contrivance can ever "realize the full theoretical value of the jet." All that may be claimed is, that a more or less high percentage of the theoretical free energy contained in gravitating water will be realized with a more or less perfect mechanism applied to the purpose. So far as the engineering profession knows by theory and practical test, the Pelton wheel realizes the highest percentage of energy from water ejected under pressure or head. If Mr. S. knows of even a yet "more perfectly formed" mechanism, he owes it to himself and to humanity at large to set it to work. But his exaggerated claim for the Atkin wheel leaves him under suspicion, that the more perfect form of which he speaks, has existence in imagination and exaggeration only. Yours truly, F. M. F. Cazin.

New York, Dec. 10, 1892.

(Our correspondent is entirely correct in his statement that the Atkins wheel is in no proper sense an anticipation of any feature of the Pelton wheel, except that it misapplied a neglected theoretical principle which has been applied with such skill and success in the Pelton wheel. This becomes very clear from the accompanying plan of the Atkins wheel, reproduced from the patent specifications (dated Aug. 10, 1875 and now expired) in which an ordinary form of turbine wheel is shown with a new and probably very inefficient style of buckets, supplied by the conduits C C. Therefore it would be entirely improper that Mr. Atkins' name should be connected in any way with the Pelton wheel, still less that he should be regarded as it originator. He was "hot," as children say, in thinking that the reaction principle might be usefully applied, but he made no approach to any useful way of doing so. Our correspondent himself falls into error, as we understand the facts, in speaking of the double concavity of the Pelton bucket as merely to divert the water " so as not to impede continuous action." On the contrary, this double-concave form is the very essence of the device, on which its high efficiency depends. Without it, it would become a rude sort of current water wheel of low efficiency and less practical value. With it, it is one of the neatest pieces of mechanism of modern discovery.—Ed.)

THE CABLE LAYING STEAMER "MACKAY-BENNETT."

The Commercial Cable Co. owns a steamer, the "Mackay-Bennett," which is employed in repairing breaks which may occur in the company's submarine cable. From an article in the "Marine Journal" we take the following description of this vessel and her equipment, and the vessel is now undergoing repairs at the Erie Basin, in Brooklyn, N. Y.:

The "Mackay-Bennett" was built at Govan, on the Clyde, in 1883, at a cost of $320,000. She was then fitted out with all the apparatus for deep sea cable duty known at that period, but new machinery and improved appliances in great quantity have been added as they have become known. She is built of steel. Her length is 270 ft., beam 40 ft., net tonnage 1,012 and gross tonnage 1,700 tons. She is propelled by twin screws, with two independent sets of compound, inverted cylinder, direct acting, surface condensing engines. On her trial trip she attained a speed of more than 12 knots. Her coal capacity is 750 tons.

There are three cable tanks, located forward, amidships and aft. They are situated between the deck and lower hold, have a diameter of 20 to 30 ft., and in the center of each is a large iron cone about 10 ft. high, around which the cables are coiled ready for use at any time. The capacity of each tank varies according to the size of the cable. The Commercial Cable Co. has seven sizes, the after tank, for instance, having capacity for coiling 130 nautical miles of deep sea cable, weighing 240 tons, while the off shore end size only 19 knots, weighing 323 tons can be stowed.

The cable is laid from the after tank. In this process the end of the cable is picked up from the tank and carried up to the deck by machinery located almost directly over it. It is then carried around a large grooved wheel and between two smaller wheels, so placed as to keep the cable taut when the vessel is pitching. Thence the cable passes three times around a wheel 6 ft. in diameter, which is controlled by a brake and under a dynamometer, which registers the strain upon it. From this the cable passes aft, where it leads over a wheel placed between the stern sheaves and into the sea. Above the last wheel are two of smaller size, used when cable is being hauled on board, to clutch the ends so that "stoppers" may be placed around the ends to hold them in place. Extending beyond the stern are platforms upon which seamen engaged in work may stand in safety.

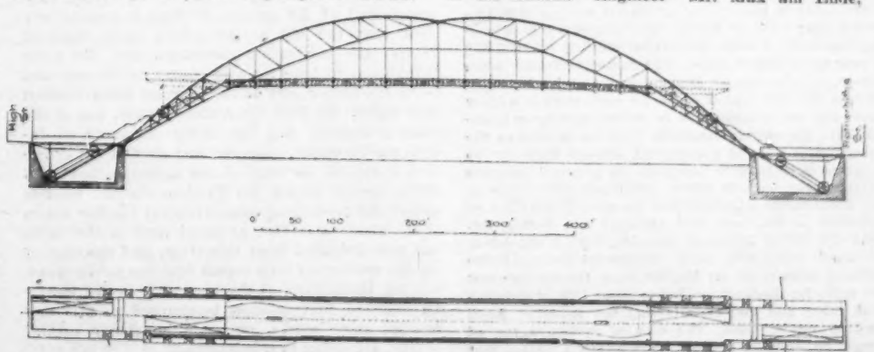
There is on the poop deck one of James' submarine sentries and sounding machines, the primary object of which is to give instant warning of the approach of the ship to shallow water. In such an event the sentry strikes bottom, frees itself automatically and rises to the surface, simultaneously sounding an alarm on board, thus giving immediate notice of danger in time to avert disaster (Eng. News, Sept. 8 and Oct. 6).

On the forward deck is another machine somewhat resembling the one aft, but used chiefly for gripping and picking up cable. It has a single drum, driven by a two-cylinder engine, fitted with a clutch for single or double purchase, and a brake for paying out with the engine thrown out of gear. The cable is brought up from the sea by a grapnel and a man is lowered over the bows, the ends of the cable secured, "stopped" and cut, and necessary repairs made, after which the cable is allowed to sink into the sea again.

The task of picking up a cable is sometimes a tedious one, especially in deep water, such as is found to the eastward of Flemish Cape, on the coast of Newfoundland, where the "Mackay-Bennett" has worked in 2,500 fathoms. When once brought up by the grapnel the cable is cut and an electrical test by an expert may readily tell how far distant the steamer is from the break to be repaired.

A LOW-LEVEL-APPROACH, HIGH-LEVEL BRIDGE.

The crossing of the River Thames below London Bridge is a favorite problem with English engineers, and the Tower lift-bridge is the latest solution being actually worked out. In a recent issue of the London "Engineer" Mr. Max am Ende, M. Inst. C. E., proposes the design here shown for a contemplated crossing at Rotherhithe, and recommended as having a greater traffic capacity than the steam ferry scheme lately adopted by the London County Council for this site.



PROPOSED BRIDGE OVER THE THAMES AT ROTHERHITHE, LONDON; Max am Ende, M. Inst. C. E., Engineer.

This bridge would have a clear span of 782 ft. and a suspended concrete roadway, 42 ft. wide, at

90 or 120 ft. above the water surface. The peculiarity lies in the inclined railways at the two approaches, which transfer the traffic from the street to the bridge level at intervals of two or three minutes, and obviate the necessity for long and very costly approaches.

There would be two lifts at each end of the bridge each about 80 ft. long and 27 ft. wide. These would be operated alternately, one rising while the other is descending. If so desired each lift can be again divided transversely into two halves, and one part only used at the hours of small traffic. These lifts would travel on rails set on an angle of about 33°, and be hauled by wire cables connected to each lift in such manner as to always balance the weight of the lifts. The motive power would be hydraulic pressure, regulated by accumulators.

Mr. am Ende claims as one advantage of this type of bridge that the level of the roadway can be raised or lowered, at a comparatively small expense, to meet future contingencies. He estimates the cost of the bridge for Rotherhithe at less than $1,250,000; whereas the proposed ferry, with its land, etc., is estimated to cost $2,090,000.

RAILWAYS AND HYDRAULIC WORKS IN INDIA.

The bad management of the government of India in regard to the railways and public works of that country is a frequent subject of discussion by English and Indian technical and other papers, and it cannot be doubted that the best interests of the country are not being served by the present methods of the government. A comparison between railways and railway practice in India and the United States, showing the excessive cost and inadequate accommodation of the Indian railway system and the failure of the government and railway engineers in India to recognize and meet the general requirements of the country in regard to railway facilities was given in our issue of Aug. 4, 1892, and in our issue of Nov. 10 we gave extensive particulars relative to the irrigation works of India. From Gen. John F. Fischer, of the Royal Engineers, a prominent engineer in the Indian public service, who has had charge of some of the great hydraulic and irrigation works in that country, we have received an interesting pamphlet on "Hydraulic Works for India," which opens with a severe arraignment of the management of Indian railways, strongly emphasising the remarks made in our article above referred to, and incidentally showing some of the objections to government ownership of and political interference with the railways and other public works.

For the last 50 years railways have been established in India, to develop her resources, and have cost for construction over £13,000 ($65,000) a mile, for single narrow-gage lines chiefly. The freight traffic on them is costing the country over 12s. ($3) a ton a year to move, and, with a population of 287,500,000, the passenger traffic is only about 120,000,000 in the year, while the government is losing over £2,000,000 sterling ($10,000,000) a year by these works. The freight traffic is costing the country some £10,000,000 sterling ($50,000,000) a year more than it ought. The passenger traffic, when compared with that of England and America is simply absurd, and the rate of speed for such work is equally poor, but the moment this is pointed out by any one we have the old cry repeated, "Oh, he is abusing the government!", as if government existed here for no other purpose than to maintain the personal interests of the lucky ones in office. India has been made to pay £230,000,000 ($1,150,000,000) for some 17,000 miles of railways in the past half century; and during this time the United States of America, with a population of about 50,000,000, have constructed some 170,000 miles of railway on the English gage, the average cost per mile, for double lines, being about £12,000 ($60,000) with labor and materials costing ten times as much as they do in India. The cost of moving a ton of freight in America is about 1s. (25 cts.) a year, about the same as it is on English canals, one-third of the rate obtaining on English railways, and less than one-twelfth of the charge made in India for exactly the same work. Punctuality and rate of speed on the American lines are everything that can be desired, and their accounts are kept up and published within one month of the close of the year. Their passenger traffic is about four times that of India, with a population which is less than a quarter of that living in this country. . . . In India, a wretched tank cannot be built or a miserable road tunnel built without the government being dragged in, in one way or another. How, then, is it possible to describe or discuss a policy when the whole population is kept in a turmoil of fear and apprehension by the selfish aims and purposes of the underlings in office.

The writer then takes up the subject of irrigation and hydraulic works in South India, pointing out the results of 40 years' experience, showing how some fearful losses have been entailed on the community, and to how great an extent negligence and mismanagement have prevailed. A history of these works, he says, would display much jealousy and mismanagement. As an example, it is stated that in reference to the restoration of the Dondapad Tank, in one of the most famine stricken parts of Madras, the superintending engineer assumed that 1 sq. mile of catchment area or basin will irrigate 40 acres of land. The average rainfall being only 24 ins. On this the Chief Engineer for Irrigation remarked that in average years it is not likely that more than 30 acres can be supplied and that in years of scarcity of rainfall the full estimated area would not be irrigated, while in exceptionally bad years there would be practically no irrigated crops brought to maturity.

When such small-minded, narrow ideas are allowed to prevail, how is it possible to do any good to the country in general? This officer, high in the confidence of his government, evidently thinks, so far as the people are concerned, that for them no loaf at all is better than even one quarter, and that their cattle, the principal means of their sole industry, may be allowed to perish for want of drinking water and fodder, for fear the government should lose a little revenue. It would not have been worth while to notice such ideas were it not that the whole country has been deprived of all hydraulic works by such crude notions being accepted as the very height of wisdom, and actually acted upon, to the ruin of its population, and, of course, of the government revenues.

The native governments have acted very differently. In one part of the Madura district there are over 3,000 tanks or reservoirs within an area of less than 400 sq. miles. Recognizing the enormous value of water to the land, the natives of South India have from time immemorial used every means in their power to secure a good supply for irrigation purposes. An immense amount of labor must have been expended on some of the ancient works, which shows what importance the people attached to such works, as they labored voluntarily to secure the benefit of them in every possible way. The average rainfall for the tropics is very small, only about 30 ins., but the natives did not hesitate to bestow the greatest labor on such works, to secure as much water as possible, for the good of the community, while the English rulers "are not ashamed to declare that the people may perish in bad years, out of actual fear that some little revenue may be lost to the government."

In the early days the natives of the Tanjore district utilised the waters of the Cauvery River for irrigation on the delta of that river. When this district came into British possession at the commencement of the present century it became evident that the old native works were radically faulty, the cultivation decreased, and the river threatened to take its own course to the sea and leave the larger part of the Cauvery delta without any water. In 1835 Sir Arthur Cotton, one of the most prominent and far seeing engineers on Indian public works, proposed and carried out extensive works at the head of the delta, so that from being nearly ruined the Tanjore district became one of the most flourishing. General Fischer states that "above a million acres of land in the delta are now irrigated from this river, and the cost of all the works has been repaid into the public treasury ten times over, at the least; but it will hardly be believed that interest is charged to this day against these works, on some imaginary capital outlay, according to regulations."

We cannot here go into the details of the various works reviewed in Gen. Fischer's pamphlet, but he shows how low water is in many cases allowed to run to waste, although needed and easily stored for irrigation, owing to lack of energy and to disputes between the native state and English government. On the other hand, some work constructed by the British government are said to be all wrong in principle, and the outlay on them almost useless, owing partly to "mischevious blundering." On the Tungubudra River the native constructed, in ancient days, no less than nine "anikuts" or dams for supplying irrigation canals which still exist.

They are all admirable specimens of the laborious industry the people went through to secure a supply of water, however small. Some of the dams are more than a mile in length, made of rough stones weighing from ½ ton to 5 or 6 tons, which must have been carried by main force and placed in the bed of the river in pretty regular courses, the interstices being filled in with smaller stones. The height of these dams varies from 10 to 20 ft., to suit the depressions in the river bed. When one contemplates the work done here just to get some 10,000 acres of land irrigated by the rudest and most laborious means, it is humiliating to think that, with all our boasted scientific engineering, nothing whatever has been done to improve upon the example left us by the people. Years ago, Sir Arthur Cotton proposed to irrigate a million acres from this river, and entrusted the work of surveying and leveling for this purpose to one of his trained subordinates, who carried it out to his entire satisfaction, having found a sight for a very large reservoir in the Tungubudra, so that an abundant supply of water would have been always secured for fully a million acres of land in the Bellary and Kurnool districts. Sir A. Cotton sent in the papers as long ago as 1859, and from that day to this nothing has been done in the matter, beyond losing all those papers and preventing the officer above mentioned from going back to the district to do the work again, though he has frequently offered to do so, and is well acquainted with every inch of the ground. In the last famine the Bellary district lost over 30% of its population, the loss of revenue was nearly 90%, and the government spent upward of 150 lacs ($3,000,000) in maintaining the people on works, not one of which is worth Rs. 10 ($3). Had 300 lacs ($6,000,000) been spent on the works proposed by Sir A. Cotton, a return of 15% would have been easily realized in this district, all the losses would have been saved, and the population secured for ever from famine; whereas, now, the government are at their wits end to know what to do to prevent their recurring. The only thing they seem to be pretty certain about, is that, as long as it can be avoided. Sir A. Cotton's ideas and principles shall not be acted upon, as if a blessing could possibly be secured in this manner, by leaving the people to perish by the thousand.

Many such instances are given of the apparent apathy or wrong-headedness and blundering of the government and its officials; and the progress of hydraulic works is said to have been almost stopped by the little interest taken by the government in establishing works to which the people attach the utmost importance. In one case objections were made to the construction of a reservoir on the ground that the foundations would be in sand and that the rock of the hills on each side were probably not watertight. But some very heavy works on other rivers have been built on sand, which proved a very excellent foundation if properly protected from running water, and the latter difficulty was overcome in a large reservoir built ages ago by the natives, where the hills were composed entirely of basaltic boulders, by simply covering them with a common earth bank. Of this particular project General Fischer writes: "Considering the desolate character of the whole valley below the site of the reservoir for more than 100 miles, and the ruin and misery prevailing throughout its length and breadth, it is marvellous to think that any objections could have been raised to the only work which could afford some alleviation to the people living in it; and when we remember that this work presents no difficulties whatever to modern engineering science, we can but hope that it will be carried out shortly."

The land revenue system is considered as largely instrumental in keeping the people at large, and especially the ryots, or native cultivators, from putting confidence in the government or its agents. The natives are said to be industrious, keenly alive to their own interests, and willingly cooperating to promote them when they see that the officers and agents are working in this direction, but stubborn and crafty in the extreme when they find that the officials are simply trying to get more revenue out of them for their own personal profit and promotion. As a result of this system the whole mass of the population is said to employ every crafty means to defraud the government, English or native. The ryots naturally will not improve their methods of cultivation when a man cannot even plant a tree without the taxgatherer making an increased demand upon him. It is an

erroneous impression that the ryots are idle and will not work, but they are not likely to be made more industrious by the corruption and extortion practiced by the landlords and officials, as instanced in the pamphlet before us. General Fischer speaks very highly of the native officers who worked under Sir A. Cotton and himself, and of the laborers, who worked willingly for twelve or fifteen hours a day.

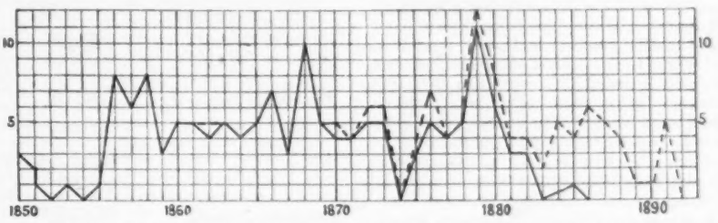
Among the successful works which have been carried out are the Godavery and Kistna anikuts, or dams (on the rivers of the same names), both of which were designed by Sir A. Cotton. The Godavery dam is of stone, 12,000 ft. long and 14 ft. high, built on wells sunk 6 ft. deep in the sandy bed of a river which rises in floods upwards of 30 ft., and flows with a velocity of about 5 miles an hour. A substantial apron receives the overfall, and the weir is also fitted with sluices for distributing the water to the various channels for irrigation and navigation purposes. About 1,000,000 acres are to be brought under irrigation, and 700,000 acres are already cultivated, raising valuable and regular crops in perfect security. The Kistna dam is 3,900 ft. long and 20 ft. high, built on wells 6 ft. deep sunk in the sandy bed of the river, and is provided with a substantial apron, irrigation and under sluices, and locks, etc., for irrigation. This river rises 40 ft. in heavy floods. The water storage here will ultimately irrigate some 500,000 acres. The objection to navigation on the canals is said to be largely due to the fact that the canals are not navigable throughout as a complete system, but the navigable canals are said to give the best financial returns from the lands irrigated. Some large works are now in progress, and other important works in South India, which can easily be carried out, are suggested. As to the big dams for such works General Fischer expresses the opinion that the section should be as nearly as possible that of the Great Pyramid of Egypt, the increase in material being compensated for by the increase in stability, but it does not seem to us necessary or advisable to depart so largely from the more economical section used in large modern dams of proper construction, as exemplified in the Tansa dam for the Bombay water supply (Eng. News, June 30, 1890).

General Fischer shows very clearly the defects in the present system of governmental control and the necessity for many additional works in the south of India, but there seems little probability of the immediate introduction of any better system of management for either the railways or hydraulic works, in both of which much might be learned from practice in the United States.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.
XXXVI.

The diagrams showing graphically the distribution of students' time at our several colleges will not appear until our issue of Jan. 5, 1893, in order to afford full time for corrections of the data given in Tables XXXIII. and XXIV. (Eng. News, Dec. 1 ,1892), on which they will be based. For the same reason, no installment of these articles will appear in our next issue.

We observe in the Troy (Rensselaer) "Polytechnic" the accompanying diagram, showing the number of graduates from each class of the Institute who have since become members of the American Society of Civil Engineers. In addition to those shown on the diagram, there were four members of classes earlier than 1850 who are not shown on it. Including these four, 36 graduates in all of classes earlier than 1860 became full members out of a total of 148 such graduates, or 24.3%. This shows conclusively, we think, that in the comparisons lately made as to relative accessions to the Am. Soc. C. E. from each college, Rensselaer to the Am. Soc. C. E. from each college, Rensselaer Polytechnic Institute, Massachusetts Institute of Technology or any other college in the basis of comparison that we used; and hence that it could not fairly claim to stand at the head of the list, though it can claim, and we freely granted, that it is separated by the only college which precedes it by so small a shade of difference as to make the difference of no significance. From the combined effect of the great age of the school and its high grade of excellence no less than 190 graduates in all (176 living, 14 dead) have become connected with the school, being about 11% of the total number, and nearly four times as many as from any other school in the country.



NUMBER OF GRADUATES OF EACH CLASS OF THE RENSSELAER POLYTECHNIC INSTITUTE SINCE 1849 WHO HAVE BECOME MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

As very few of the other colleges began to turn out graduates in any considerable number before 1867-69 it will be seen by a glance at the diagram that it is yet too early to draw any definite conclusions as to what the relative status of the colleges will be in this single respect, ten or fifteen years from now.

The solid lines of the diagram show the number of full members, and the dotted lines the number of accessions to all grades of the society.

COST OF CONSTRUCTING AND OPERATING RACK RAILWAYS IN EUROPE.

The use of some form of rack and pinion as an expedient for reducing the disadvantages of gradients on mountain railways, is familiar to most engineers. Although the United States may justly claim credit for the first example of a rack railway, viz., the Mt. Washington Ry., built by Silvester Marsh in 1869, nearly all the most important lines of this type are confined to the European continent, and principally to one country, Switzerland. In a recent number of "Engineering," some interesting figures of the physical features of a large number of the most important rack railways completed or in process of construction in Europe are given, with details of operations of four of these having the largest business. In Tables I. and II, accompanying, we have rearranged the more interesting of these figures.

system seems the one which promises the most general usefulness and which is being adopted most extensively for railways of this class.

In Table II. are shown the general results of the operations of four of the longest and busiest of the lines given in Table I. The number of passengers carried varies from 101,132 per season, or 843 per day, on the Righi line, to 19,304 per season, or 161 per day, on the Generoso line. The working season of all of these lines is about four months, and the authorized passenger fare 30.6 cts.

TABLE I.—Showing Length, Maximum Grade, Cost and Gage of the More Important Rack Railways in Europe.

Date of completion.	Name and location.	Length, miles.	Max. grade, per cent.	Cost of Construction and equipment.	Gage.
1871 (2).	Righi (Lucerne)	4.34	25	$102,680	4 ft. 8½ ins.
1874 (2).	Kahlenberg (Vienna)	3.41	10	53,120?	"
1875 (2).	Arth Righi (Zug)	6.92	21	136,320	"
1875 (2).	Rorschach-Heiden. (Constance)	3.41	9	128,000	"
1875 (3).	Uthberg (Zurich)	5.70	7	55,680	"
1880 (2).	Friedrichsegen (Lahn)	1.55	10	24,000	3 ft. 5 ins.
1883 (2).	Drachenfels (Rhine)	0.95	20	48,000	"
1887 (2)	Gaisberg (Salzburg)	3.35	25	99,200	"
1888 (2)	Stuttgart	6 51	17.3	24,320	"
1889 (4)	Pilatus (Lucerne)	2.66	48	179,520	2 ft. 7½ ins.
1889 (2)	Achensee (Tyrol)	3.96	16	104,320	3 ft. 3 ins.
1890 (1)	Generoso (Lugano)	5.27	22	64,000	2 ft. 7½ ins.
1892 (1)	Rothhorn (Brienz)	4.71	25	88,420	"
	In process of construction:				
	Wengern Alp (Interlaken) (5)	3.72	20	71,040	3 ft. 3 ins.
	Schynig Platte (Interlaken) (2)	3.72	20	71,040	"
	Glion Naye (Montreux (1)	4.71	22	84,160	2 ft. 7½ ins.
	Mont Saleve (Geneva) (1)	5.57	25	78,300	"
	Aix les Bains-Revard (1)	5.57	22	124,480	3 ft. 3 ins.
	Schafberg (Salzkammergut) (1)	3 72	25½	96,000	"
	Montserrat (Barcelona) (1)	4.40	15	112,969	"

(1.) Abt's rack and pinions. (2.) Riggenbach's ladder and engine. (3.) Adhesion only. (4.) Locher's double vertical ladder and horizontal pinions. (5.) Riggenbach's rack and Abt's pinion engine.

TABLE II.—Showing Capital Investment, Income and Operating Expenses of the Righi, Pilatus, Generoso and Utliberg Rack Railways.

Line.	Capital expended on line and equipment.	Length, miles.	Number of passengers carried per season.	Gross earnings.	Operating Expenses. Maintenance and superintendence. Per tr. mile.	Maintenance and superintendence. P. c. of total.	Train service and carriage repairs. Per tr. mile.	Train service and carriage repairs. P. c. of total.	Locomotive power and renewals. Per tr. mile.	Locomotive power and renewals. P. c. of total.	Administration and general repairs. Per tr. mile.	Administration and general repairs. P. c. of total.	Total per train mile.	P.c. of opr. exp. to gross earnings.	Net earnings.	Net return on capital, P. c.
					$		$		$		$		$			
Righi	$147,000	4.34	101,132	$92,412	0.58	23	0.48	18	1.06	40	0.20	10	2.16	41.7	$53,843	7
Pilatus	442,400	2.66	37,317	23,278	0.18	11	0.40	16	1.38	56	0.42	17	2.42	42.2	31,945	5
Generoso	302,000	5.27	19,304	18,577	0.12	12	0.16	16	0.69	57	0.16	15	1.06	51.6	8,892	2
Utliberg	325,000	5.70	67,421	19,480	0.16	23	0.10	17	0.22	49	0.08	11	0.66	59.7	7,844	2

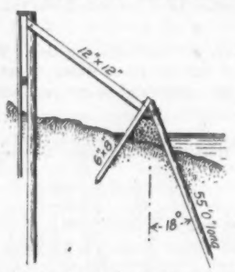
From Table I. it will be seen that, prior to 1890, the Riggenbach system was the one most universally adopted. This system was largely modelled after that used on Mt. Washington, and, in fact, for some of the first lines, especially the Righi, was an exact copy in all essential details of the system used by Mr. Marsh on the Mount Washington line. Since 1890, however, the Abt system (Eng. News, May 22, 1886), has been more generally adopted; seven of the nine lines completed or put under construction since that time being of that type as shown by the table. At present this per mile. To the unusually short season and the high rates is undoubtedly due the very small percentage of gross earnings absorbed by operating expenses. As might be expected locomotive power and renewals form a very large proportion of the operating expenses. It is interesting to note at this point that the Righi line with a maximum grade of 25%, shows a considerably smaller expenditure for locomotive power, both per mile of line and in percentage of total operating expenses, than the Pilatus, with a maximum grade of 48%, although it has nearly two-thirds more traffic.

Philadelphia has a population of 1,142,653, according to the late police census ordered by the Mayor. This is an increase of 95,689 over the U. S. census of 1890.

LEVEE PROTECTION, NEW ORLEANS.

City Engineer Brown, of New Orleans, La., has submitted plans for bulkheading a "caving" levee bank in that city, extending over a length of 888 ft. The following is a description of the method proposed, as taken from his specifications:

At a distance of about 15 ft. from the present alignment of the bulkhead there will be driven on an angle of 18° with the perpendicular piles 55 ft. long, 5 ft. centers. These piles to be driven in an even and uniform manner and will receive a stringer of wharf timber placed on the rear side of the piles and screwed to each pile by two ⅞-in. machine bolts with cast iron washer under head and nut. After the piles are driven and the cap placed in position the batture in front of the piles will be filled in with willow saplings in about the manner shown on plan. After the willows are placed in position, a staub 6×8 ins. will be securely driven into the ground on an angle, and be secured to the stringers at every



Proposed Method of Protecting Levees, New Orleans, La.

5 ft. For the purpose of bracing the high bulkhead there will be placed at every post of this high bulkhead a 12×12 in. sawn cypress timber framed out to fit the piles of the high bulkhead and rest on top of the stringers behind the pile of the low bulkhead. A rag bolt ¾-in. square will secure the toe of this strut to the stringer of the low bulkhead, and the top of the high bulkhead by one ⅞-in. screw bolt, provided with cast iron beveled washer under head and nut.

A plank 4 ins. thick will be spiked on to each pile of the high bulkhead, forming a buttress for the strut, and secured to the face of the pile by five 10-in. spikes.

The point at which the stringer on the low bulkhead will be placed will be determined by the stage of the water, it being understood that it be placed as low as possible, and the piles of this low bulkhead will be sawn off to a uniform height. The piles are to be of good quality of wharf timber not less than 12×12 ins. at butt and 10×10 ins. at blossom end.

COST OF BRICK AND PIPE SEWERS AT TORONTO, ONT.

The following detailed information regarding the cost of sewers constructed at Toronto, Ont., in 1891, is from the last annual report of the city engineer of that city. The figures, however, have been entirely rearranged and classified by sizes of sewer, material excavated and average depth of excavation. In addition totals and averages for each size of sewer and material excavated are given, together with totals and averages for all sewers of the same size without regard for the material excavated.

The figures in Table I. are for sewers built by contract and in Table II. for sewers built by day labor. As there are so many variable elements in the tables a comparison would have little significance. The same is true of comparison of cost in different materials.

Bricks for street pavements have been practically condemned for use in St. Louis by a special committee of the Board of Public Improvements. They visited and examined the brick pavements of a number of large cities, including Philadelphia, Washington, Wheeling, Chicago, Cincinnati, Columbus, and Newark. As a result they reported that in these places brick pavement has failed to give satisfaction, chiefly through a lack of uniformity in burning the bricks. The committee, therefore, does not recommend brick as a suitable material for paving streets, but thinks it might be safely used in paving many of the alleys of St. Louis.

A great dam is proposed on the Guardarrama River, near Torrelodones, Spain. The London "Engineer" says a fall of 200 ft. can be obtained there now, and this can be increased to 1,100 ft. by building a canal, 5 miles long. The power obtained would be used to run dynamos and the current generated then transmitted by wire to Madrid, for lighting the city and for other purposes. To equalize the power and provide water in the dry season, a canal 15 miles long could be built connecting Lake Pantano with the river, and the lake be thus utilized as a storage reservoir. The plan would also include using the water after it passes the dam for a water supply to Madrid and for irrigation in that neighborhood.

TABLE I.—Cost of Sewers Built by Contract in Toronto, Ont., in 1891.

Size and material.	Av. depth.	Soil.	Length.	Man-holes.	Catch basins.	Connec-tions.*	Contr't price.	Total cost.	Cost per foot.†
2×3-ft. brick	16 ft. 3 in.	Quicksand.	3 750	13	24	251	$22 500	$23,602	$6.29
" "	16 ft. 0 in.	Clay.	2,431	12	14	123	11.575	12,756	5.24
" "	13 tt. 7 in.	Clay and Sand.	6,579	23	46	472	29,438	30.775	4 66
" "	16 ft. 6 in.	Loam and gravel.	693	3	4	47	3.927	4,509	6.51
Totals and averages	14 ft.11 in.		13,455	51	88	893	$67,440	$71,642	$5.32
18-in. pipe	11 ft. 0 in.	Clay.	1,020	3	2	...	1,885	2,052	2.01
15-in. "	13 ft. 0 in.	Quicksand.	519	2	2	30	1,499	1.772	3.41
" "	12 ft. 6 in.	"	447	3	2	15	885	1.294	2.90
" "	12 ft. 6 in.	"	1,026	4	6	82	2.075	2, 83	2.23
" "	11 ft. 6 in.	"	744	4	4	48	1.703	2,195	2.93
Totals and averages	13 ft. 3 in.	"	2,736	13	14	175	$6.157	$7,544	$2.76
15-in. pipe	13 ft. 0 in.	Clay.	669	3	4	46	1,143	1,300	1.97
" "	12 ft. 6 in.	"	1,185	5	10	70	2.181	2.468	2 13
" "	12 ft. 2 in.	"	633	3	4	46	1,133	1,317	2.08
" "	11 ft. 6 in.	"	677	3	2	50	999	1,181	1.37
Totals and averages	12 ft.4 in.	"	3,164	14	20	212	$5,453	$6,156	$1.95
15-in. pipe	14 ft. 0 in.	Hard clay.	1,224	4	6	81	2,092	2,460	2.01
" "	6 ft. 3 in.	Red clay.	954	5	4	68	1,133	1.690	1.77
" "	12 ft. 4 in.	Clay loam.	868	4	4	51	1.447	1.832	2 11
" "	11 ft. 6 in.	"	1,026	4	6	48	1,851	2,693	2.04
Totals and averages	11 ft.10 in.	"	1,894	8	10	99	$3.298	$3,925	$2.07
15-in. pipe	12 ft. 0 in.	Sand.	810	5	6	13	1,656	1,907	2.38
" "	14 ft. 9 in.	Sand and gravel.	1.470	5	6	93	2.812	3.193	2.11
" "	11 ft. 1 in.	"	1 641	8	12	128	3.297	3,557	2 16
Totals and averages	14 ft. 5 in.	"	3,111	13	18	223	$6,109	$6,630	$2 11
15-in. pipe	14 ft. 6 in.	Sand and loam.	293	..	..	...	698	813	2.77
" "	13 ft. 0 in.	"	831	4	6	52	1,569	1.804	2 16
Totals and averages	13 ft. 4 in.	"	1,124	4	6	52	$2.267	$2,617	$2.33
Totals and averages, 15-in. pipe, all material	13 ft. 1 in.	As above.	12,029	52	68	764	23,287	26,902	2.24
12-in. pipe	12 ft. 0 in.	Clay.	974	6	10	58	1,624	1.868	1.91
" "	11 ft. 3 in.	"	741	3	4	48	1.547	1.329	1 78
" "	10 ft. 6 in.	"	304	2	2	4	402	458	2.85
" "	9 ft. 3 in.	"	876	5	..	45	599	734	.84
" "	9 ft. 2 in.	"	703	3	4	46	1,034	1,240	1.76
Totals and averages	10 ft. 6 in.	"	3,598	19	20	201	$5,206	$5.629	$1.56
12 in. pipe	13 ft. 0 in.	Clay loam.	686	3	4	48	1,164	975	1 42
" "	11 ft 4 in.	"	854	4	6	48	1,294	1.447	1.69
Totals and averages	12 ft. 1 in.	"	1,540	7	10	96	$2,458	$2,422	$1.58
12-in pipe	12 ft. 6 in.	Sand.	1,262	5	8	38	2,078	2,430	1 92
" "	11 ft. 6 in.	"	1,165	5	4	84	2,728	2.077	1.77
Totals and averages	12 ft. 0 in.	"	2,427	10	12	122	$4,806	$4,507	$1.82
12-in. pipe	15 ft. 8 in.	Sand and gravel.	866	4	6	62	1,825	1,976	2.28
Totals and averages, 12-in. pipe, all material	11 ft. 9 in.	As above.	8 431	40	48	481	14.295	14,525	1.72

* Single 6-in. pipes about 1 ft. long in brick, and Y-junctions in pipe sewers. † Including inspection.

TABLE II.—Cost of Sewers Built by Day Labor in Toronto, Ont., in 1891.

Size and material.	Av. depth.	Soil.	Length, ft.	Man-holes.	Catch basins.	Connec-tions.*	Total cost.	Cost per ft.†
2⅛ × 4-ft. brick	21 ft. 2 in.	Hard clay.	2,295	8	10	170	$17.733	$7.73
2⅛ × 3-ft. brick	18 ft. 8 in.	Clay and sand.	1,737	6	1	...	18,173	10.41
15-in. pipe	10 ft. 0 in.	Quicksand.	351	2	3	19	794	2.26
" "	12 ft. 2 in.	Soft blue clay and sand.	2,781	9	19	190	8,170	2.93
Totals and averages, 15-in pipe, all material	11 ft. 11 in.	As above.	3,132	11	22	209	8,964	2.86
12-in. pipe	12 ft. 1 in.	Quicksand.	153	1	..	1	402	2.57
" "	10 ft. 8 in.	"	687	3	4	2	1,344	1 95
" "	10 ft. 0 in.	"	198	1	2	12	284	1.44
Totals and averages	10 ft. 10 in.	"	1,041	5	6	15	2,030	1.95
12-in. pipe	12 ft. 5 in.	Clay.	309	2	3	13	703	2.27
" "	12 ft. 0 in.	"	303	1	2	12	262	1.19
" "	11 ft. 4 in.	"	248	2	2	6	417	1.68
" "	11 ft. 3 in.	"	396	2	2	20	513	1.37
" "	11 ft. 3 in.	"	1,049	1	1	68	1,214	1.15
" "	11 ft. 0 in.	"	1,400	4	6	38	1,195	.85
" "	10 ft. 8 in.	"	249	1	1	17	410	1.64
" "	10 ft. 0 in.	"	194	4	4	50	457	2 35
" "	10 ft. 0 in.	"	279	2	..	16	438	1.57
Totals and averages	11 ft. 2 in.	"	4,427	19	21	240	5,639	1.27
12-in. pipe	9 ft. 9 in.	Hard clay.	433	4	2	24	831	1.78
" "	18 ft. 0 in.	Blue clay.	650	3	..	..	1,375	2.11
" "	12 ft. 1 in.	"	180	1	..	15	397	2.20
" "	11 ft. 6 in.	"	251	..	..	4	605	2.41
" "	8 ft. 1 in.	"	800	3	4	29	1,062	1.33
Totals and averages	12 ft. 4 in.	"	1,881	7	4	48	3,43 9	1.83
12 in. pipe	11 ft. 2 in.	Clay loam.	430	2	2	13	413	.93
" "	10 ft. 8 in.	"	357	3	..	17	679	1.90
Totals and averages	11 ft. 11 in.	"	787	5	2	30	1,092	1.39
12-in. pipe	11 ft. 0 in.	Hardpan.	320	2	2	18	412	1.28
" "	11 ft. 3 in.	Sand.	535	3	2	5	804	1 50
Totals and averages, 12-in. pipe, all materials	11 ft. 4 in.	As above.	9,474	45	39	380	14,277	1 51
9-in. pipe	9 ft. 1 in.	Hardpan.	173	1	2	12	169	1.37

* Single 6-in. pipe, 1 ft. long in brick, and Y-junction in pipe-sewers. † Including inspection.

A BOILER FOR WORKING STEAM DRILLS.

A convenient arrangement of a steam boiler for operating rock drills has recently been brought out by Thos. Carlin's Sons, of Allegheny, Pa., and is illustrated herewith. The object of mounting the boiler on wheels is that it may be run out of the way when a blast is to be let off. The two four-wheel trucks will run easily around sharp curves. A water tank is provided at the back of the boiler and fuel can be carried on the front. With a coupling such as is used for steam car heating, connection between the boiler and the drill hose can be quickly made or broken. This plan obviates the location of a stationary boiler at a distance from the quarry and conveying the steam to the drills by a long pipe, which constantly gives trouble by

PORTABLE BOILER FOR CONTRACTORS AND QUARRYMEN.

filling with condensed water, and is likely to be broken by flying stones.

The boiler is provided with numerous handholes for cleaning sediment from the crown-sheet and the water leg. The smoke bonnet is so made that the tubes can be cleaned without removing the stack.

THE RECENT SURVEY OF ST. LOUIS, MO.; ITS METHODS AND RESULTS.

At a meeting of the Engineers' Club of St. Louis on Nov. 2, Mr. Colby read a paper on the recent survey of the city, describing the geodetic basis on which the work was founded, the methods of keeping notes and making computations, the method of carrying on precise leveling and the means adopted for securing bench marks on roofs and in graveyards and in streets. He gave a new theory, based on studies made by Mr. E. J. Jolley, of the constant error found in precise leveling, which he explained as being due to always holding the eye-end of the level tube in carrying it, and therefore causing a local expansion of the eye-end of the tube that diminished the longer the instrument was used at a station, and hence the error was always greatest on the back sight. The methods employed in plotting were explained and a special protractor and slide rule exhibited. Mr. Colby also spoke of the different methods of graduating stadia boards, and gave some results that showed a marked tendency to error by the point system. The following is a brief abstract of the paper:

The instruments used were a Gambe, a Fauth and two Buff & Berger transits, all reading to ten seconds. The method of taking multiple readings of the angles was on the repetition system. The area already triangulated exceeded 27,000 acres, and the number of stations occupied averaged two stations to the square mile. The base line used was from the old water tower to the city insane asylum, a length of almost six miles. The granite monument recently erected in Forest Park, near the weather station, should be hereafter adopted for the city datum, in lieu of the old city directrix, which has been destroyed. The error of closure in the triangles averaged 3.7 seconds, and the mean error per angle was 1.2 seconds. The general system of triangulation was to carry a series of primary triangles from the base line to the extreme limits of the city, with an average length of sides of about two miles, and then fill in the intermediate ground with small secondary triangles. Pole targets, which were difficult to see on account of the smoke, and were tampered with by mischievous boys, were replaced by heliotropes or flash signals, a very simple and yet effective design being employed. The flash system gave much better closure of the triangles, as the average was 4.6 seconds with the poles, and 2.7 seconds with flash signals, or an average of both systems of 3.7. The heliotropes also permitted the Morse alphabet to be used in telegraphing from station to station.

By precise leveling 743 benches have been established, or 12 per sq. mile, mostly on the stone sills of the buildings, the location of which is printed every year in the annual report of the sewer commissioner. The average error has been 1-1,000 ft. per mile, and the maximum permitted was 9-1,000 ft. per mile. If the error of closure was larger, the work was re-run. The topographic work was carried on with true azimuths. The results of some stadia observations made after 4 p. m., showed that the refraction error is so great as to make stadia more unreliable before 10 a. m. or after 4 p. m.; an error of 0.2 ft. was found in 2.0 meters. The topographic notes were kept in the form of a few brief descriptions rather than by sketches.

The results of carrying a stadia survey around the perimeter of St. Louis, that covered a distance of 40.4 miles, and in which 306 stations were occupied, with an average length of 211 meters per station, showed that the maximum error in azimuth was 12 ft. 35 ins. at a distance of 34.9 miles, and the closing error was 8 ft. 20 ins. The error in altitude in closing, after running the 40.4 miles, without checking on any intermediate benches, was 64-100 ft., with a maximum of 1.37 ft. at the 27th mile. The cost of the triangulation, topography, leveling and office work, covering all expenses for 815 working days, amounted to about $35,000, at a cost of $1.15 per acre, or 14.5 cts. per lot. The work was carried on by four engineers, with assistants, but only one party was in the field at a time, the others being busy in the office.

The traffic at New Street station of the London & Northwestern Ry., at Birmingham, England, amounts to 500 regular trains in and out daily, in addition to 250 engines and empty trains. Over the district lines about 380 passenger trains run every day, and about 470 freight trains. This number is exclusive of about 80 switching engines which are at work in the yards, and make short trips. On legal holidays and other days these figures are increased to an immense extent, as many as 900 trains running in and out of the station daily.

The telephoto is an instrument by which ships can converse at sea, officers direct their troops, or anyone hold communication at long distance over unimpeded territory, as a plain or water surface. The inventor is C. V. Boughton. The instrument consists of a series of wires and electrical apparatus, operated by a keyboard similar to that of a typewriter. There are 106 electric lights operated by the keyboard and contained in a shaft 27 ft. long, which may be taken apart and reduced to compact form. The large number of lamps is required to regulate the spaces between the letters in relative proportions. The lights flash the characters of the Morse alphabet. The dots are represented by two lamps and the dashes by twelve lamps. The late experiments were successful. The lights could be seen at Buffalo 10 miles out on the lake.

Work on the Chignecto ship-railway, according to Canadian rumor, is to be shortly resumed. The lack of funds which caused its suspension may have been overcome.

The traffic through the St. Mary's Falls Canal for the season of 1892 has been given as follows in the official report of Col. O. M. Poe, U. S. Engineer Corps: The season was 223 days long as compared with 225 days for 1891. The number of vessels of all kinds passing through was 12,580, as against 10,191 in 1891. The increase of freight tonnage over 1891 was 2,325,574 tons, in a total of 11,647,203 tons, or 20%. The increase in registered tonnage was 2,246,518 tons, in a total of 10,647,203 tons, or 27%. The total value of all freight passing through the canal in 1892 was $135,117,267.

The Gatling Ordnance Co. is about to build a steel plant at Idlewood, near Buffalo, N. Y. The purpose is to build large guns for the government on a process patented by Dr. R. J. Gatling. The plant will also be arranged for the manufacture of structural steel for bridges and buildings, and for the making of small arms and Gatling guns. Dr. R. J. Gatling is the President of the new company.

The Russian test of American Harvey-ized armor-plates has been successful. The Harvey plate was reported as being better than the French St. Chamond plate, also tested. The full details of the test are yet to be published.

Incandescent lamp manufacture and sale is getting decidedly interesting. Following up the recent decision sustaining the Edison fundamental patent on incandescent lamps, the General Electric Co. has secured an injunction restraining the Sawyer-Mann Co., a Westinghouse concern, from the further manufacture of lamps infringing the Edison patent. The court imposed the condition that the Edison Co. must sell lamps for use with Westinghouse apparatus installed prior to the first decision in favor of the Edison Co., July 14, 1891, "upon terms reasonable under the circumstances of the particular case." The General Electric Co. advertises its lamps as the only ones lawfully made; but the many small firms engaged in lamp manufacture appear to be still actively at work, and advertise 16-c. p. lamps as low as 35 cts.

The Westinghouse Co. announces that its new lamp will be ready for the market by Jan. 1, and quotes list prices of 30 to 35 cts. for different candle powers, with discounts on large orders of 10%. Besides this an allowance of 10 cts. is made for each unbroken lamp bulb returned, which makes the net cost of a 16-c. p. lamp only 17 cts. This unheard of low price is quite as startling to the small lamp makers as is the patent victory of the Edison Co. The net result promises to be a reduction in the cost of electric lighting of considerable importance.

The Committee on Standards for driving wheel centers and tires of the Master Mechanics' Association has issued a circular calling for information as to the proper standards for wheel centers over 63 ins. in diameter, and the proper allowance for shrinkage on such tires. It also asks whether a positive tire fastening is necessary with large wheels, on which driver brakes are used for service stops.

The Executive Committee of the Association has issued a circular urging upon railway companies the advantage which would accrue if the standard contours of flange and tread and the standard sizes of driving wheel centers and tires adopted by the Association were more strictly adhered to. Tire makers could then roll for stock with safety, and fill orders quickly, and railway companies could greatly reduce their stocks of tires now on hand for repairs.

Bids for the building of the seagoing battleship "Indiana" of 9,000 tons, and the armored cruiser "Brooklyn," of 8,000 tons, were opened by the Navy Department on Dec. 15. There were two classes of bids on each vessel, one for the work according to plans and specifications prepared by the Navy Department, and the other according to the plans and specifications provided by the bidder. The bids were:

Battle Ship No. 1.—Newport News ship Company, $3,233,000 on Department plans; Union Iron Works, of San Francisco, $3,150,000 on Department plans; Bath Iron Works, of Bath, Me., $3,185,000 on Department plans; Cramp & Sons, $3,010,000 on Department plans, and $3,110,000 on their own plans of one class, and $2,870,000 for their own plans of another class.

Cruiser No. 2.—Newport News Ship & Dry Dock Co., $3,147,000 on Department plans; Union Iron Works, of San Francisco, $3,050,000 on Department plans; Bath Iron Works, of Bath, Me., $3,165,000 on plan prepared by bidder; William Cramp & Sons, $2,986,000 according to Department plans; $3,096,000 according to one plan of bidder, and $2,880,000 according to a modified plan.

The New York & New Jersey Bridge project, of which Mr. Andrew H. Green, Mr. George W. Greene and Mr. Charles Swan are the chief promotors, is being vigorously opposed by Comptroller Meyers and City Chamberlain Crain. The latter gentleman characterized it as "less than one mile of bridge and 28 miles of approaches," and claimed that the project really meant a complete system of railways all over the city. This bridge plan calls for a crossing of the Hudson River at 72d St., with one approach extending down to 42d St., and across to Broadway and Seventh Ave., and another approach running along the river to 155d St., and then across the Harlem and connected at Port Morris with the New York &

New Haven railway. The bridge proper would be 3,000 ft. long between piers, and 5,000 ft. between bulkheads, and the New York approaches would aggregate 9 miles, and the New Jersey approaches 19 miles in length. Senators Hiscock and Hill have been asked to defer action on the bill now before the U. S. Senate until the municipal authorities can be heard from in protest against its passage.

The Brown wire-wound gun, described in our issue of Nov. 24, 1892, was subjected to a preliminary test at Birdsborough, Pa., on Dec. 3. The tube was only rough bored, and the object was mainly to test the working of the breech mechanism. Charges of 10, 15 and 18 lbs. of Dupont sphero-hexagonal powder were used with an 84-lb. cast iron solid shot. The breech apparatus operated easily. The second shot showed a pressure of 28,265 lbs.; but the third shot, with the projectile fitting closer than it would in practice in this rough-bored barrel, developed a breech-pressure of 60,000 lbs. to the sq. in. The copper gages used were carefully tested, with the result that they were found to be correct, and the gun in its present form successfully withstood a pressure almost equal to that of the original experiments on a close breech section. The ordinary maximum pressure in a gun of similar caliber would be about 37,000 lbs. The test was conducted by Lieut. G. N. Whistler, U. S. A.

Preliminary work on the construction of the big Cornell dam for the New York water supply is under way. Tracklaying and excavation are in progress and a bridge is being built. The contract was awarded to Mr. Jas. S. Coleman, New York, last autumn, for $4,150,573.

Further important extensions to the Brooklyn waterworks have been recommended by Mr. Robert Van Buren, Chief Engineer Department City Works, at an estimated total cost of $3,205,000. The proposed extensions include a 5-ft. supply conduit, 13 miles long, new storage ponds, a driven well station and new pumping engines.

Plans and estimates for a new water supply for Portland, Ore., have been submitted to the water committee by Mr. I. W. Smith, Superintendent and Engineer of the city water-works. The estimated cost of a wrought iron supply main, about 30 miles long, varying from 42 to 32 ins. in diameter, is $1,570,000. This includes 4,200 ft. of 24-in. submerged pipe, a 300, 160 and 125-ft. bridge. In addition Mr. Smith recommends the construction of at least six distributing reservoirs and the laying of some distribution pipes at an estimated cost of $650,000, making a total of $2,220,000 for all the proposed improvements.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

BARE ROCK.—Pres. John Murdock, Johnstown, Pa., informs us that this company, whose incorporation was noted some time ago, has completed a railway 2½ miles long way from Way Station to Bare Rock, Pa.

BALTIMORE & OHIO.—The Snow Fork & Hocking R. R. has been located from the Straitville division of the Baltimore & Ohio R. R. to Chauncey, O., 18.6 miles, and about 12 miles of the right of way have been received. It is stated that construction will probably begin in the spring. Pres., David Lee, Zanesville, O.

FALL BROOK COAL CO.—Surveys have been made for a line from Mills to Ulysses, Potter, Co., Pa., 7 miles, and it is stated that constructoin will begin in the spring.

BLACK RIVER.—Dorwin & Co., Oswego, N. Y., have the contract for this railway from Proctorsville, Vt. to Claremont, N. H., 20 miles.

BUFFALO, ROCHESTER & PITTSBURG.—It is expected to begin tracklaying on the line from Jefferson Line to Clearfield, Pa., 27 miles, about Jan. 1, 1893. Ch. Engr., J. M. Floesch, Clearfield.

PENNSYLVANIA.—Surveys have been completed for an extension of the Turtle Creek Valley branch from Delmont to Saltsburg, Pa., and the contracts for construction will be let soon.

NEW YORK, LAKE ERIE & WESTERN.—It is rumored that this company will build a second line between Olean and Addison, N. Y. The proposed line will run considerably further south than the present one and will pass into Pennsylvania.

TIONESTA VALLEY & HICKORY.—Ch. Engr. T. D. Collins, Nebraska, Pa., writes us that this railway from Nebraska to Ross Run, Pa., 5 miles, has been graded and that tracklaying will begin in April, 1893.

Projects and Surveys.

KETNER, ELBON & SHAWMUT.—Pres. B. E. Cartwright, Ridgway, Pa., writes us that the locating surveys are now being made for this railway from Ketner to Elbon, Elk Co., Pa., 40 miles.

ATLANTIC & PACIFIC.—Application will be made to the Canadian Parliament at its next meeting to incorporate this company, to build a railway from Sault Ste. Marie to the Gaspe Basin, passing through the Districts of Algoma and Nipissing and following the valley of the Ottawa River as far as circumstances will permit, passing by or near the cities of Ottawa and Montreal and running through the counties on the south side of the river St. Lawrence.

TACOMA, BURNT MILLS & SANDY SPIRNGS.—The directors of this company have ordered a survey to be made for its proposed railway from Burnt Mills to Sandy Springs, Md., 10 miles. Pres., C. G. Stone, Brightwood, D. C.

DELAWARE, LACKAWANNA & WESTERN.—It is rumored that this company is about to build a line from Hancock, N. Y., northwest to Rotterdam Junc., N. Y., about 100 miles.

Southern.—Existing Roads.

LOUISVILLE & NASHVILLE.—Construction has been commenced on the branch from Bragg's Tank, near Longview, Ala., to Lewis' Post Office, Shelby Co., 15 miles.

NASHVILLE & KNOXVILLE.—It is stated that 500 men are now grading the extension from Algood to Standing Stone, Tenn., 11 miles, and that the work will be completed in about four months. Surveys are reported begun for a further extension beyond Standing Stone to a connection with the East Tennessee, Virginia & Georgia R. R. Ch. Engr., R. J. Moscrip, Cookeville, Tenn.

ATLANTIC SHORT LINE.—The purchasers of the property and franchises of the Macon & Savannah Construction Co. and the Macon & Atlantic R. R. Co., as noted in our issue of Dec. 8, have appiled for a charter empowering the Atlantic Short Line R. R. Co. to complete the road. The incorporators named are John R. Young, W. L. Strong, Sol. Stern, Henry Rice, J. F. Hanson, J. L. McKee, H. J. Lamar, R. H. Plant and Lewis Kayton.

RICHMOND & CHESAPEAKE.—As noted in our last issue the contract for the tunnel which is to carry this railway under 8th St., Richmond, Va., together with about 1½ miles of approaches, was let to Mason, Hoge & Co., on Dec. 19. Work is to be commenced Jan. 2 and pushed as rapidly as possible. The tunnel will be 4,500 ft. long, and will carry two tracks. Its clear width between side walls will be 27 ft., and its heighth at the center about 23 ft. The section will be a semi-circular arch with a rise of 13½ ft., resting on side walls 7.9 ft. high, with an invert. The arch masonry will be of brick, 5 ins. thick or more, according to the nature of the ground, and the side walls will be of brick with stone masonry footings. The tunnel will penetrate soft ground, and will be constructed on an entirely new system, which will be described in a future issue. Pres., N. E. Reed, 35 Broadway, New York city. Cons. Engr., A. R. T. Lackie. As soon as work is well under way on the tunnel contracts will be let for the remainder of the railway, which is about 50 miles long.

TREDEGAR MINERAL.—Ch. Engr. Geo. H. Montgomery, Jacksonville, Ala., writes the "Manufacturers' Record" as follows: "It is expected to extend the Tredegar Mineral Ry. north through Cherokee Co., via the Burke Iron Mountain and Centre, the county seat of Cherokee Co., to a point on Chattanooga Southern Ry. near Taff or Bristow, Ala. The details are not yet decided, and will not be until surveys are completed. It will be a mineral road, and will greatly lessen the distance between Jacksonville, Ala., and Chattanooga, Tenn."

CHESAPEAKE & OHIO.—The grading and bridging are about completed on the branch up the Gauley River, about 7 miles, and track will soon be laid. Preliminary surveys are also stated to have been made for a further extension north and east along the Gauley River and then southwest along Meadow River to Alderson, W. Va.

NASHVILLE, CHATTANOOGA & ST. LOUIS.—The grading of the extension south of Huntsville, Ala., to Hobb's Island, in the Tennessee River, has been completed and about 10 miles of track have been laid. This leaves only five miles of track to be laid to complete the line.

WINCHESTER & BEATTYVILLE.—This 5¾-mile railway connecting Beattyville, Ky., with the Kentucky Union R. R., is practically completed.

ROSEDALE & MISSISSIPPI CENTRAL VALLEY.—Pres., Chas. Scott, Rosedale, Miss., writes us that the surveys have been made for this railway from Rosedale to Phalia, 6½ miles, and that construction is now in progress. Tracklaying is expected to begin in about 60 days and the road to be completed in four months.

Projects and Surveys.

UNAKA & NOLACHUCKY.JAn official of this company is reported as saying that the contract for constructing its proposed railway has been let to an Ohio firm. Ch. Engr., R. A. Bowie, Greenville, Tenn.

HOT SPRINGS & MT. VALLEY.—Surveys are now in progress for this North Carolina railway and it is stated that as soon as these are completed contracts for construction will be let. Gen. Man., Z. W. Ward, Jr., Little Rock, N. C.

CHEROKEE MINERAL.—A bill incorporating this railway has passed the Alabama Legislature.

ROCKWOOD & CROSSVILLE.—As noted in our issue of Nov. 24, surveys have been completed by White & Sylvester, Civ. Engrs., Rockwood, Tenn., for a railway from Rockwood to Crossville, Tenn., 29 miles. The object of the road is to connect at Crossville or some other point with one of the roads projected east across the Cumberland Plateau. The route is through a rough country and the maximum grade is 65 ft. per mile. There will be one tunnel about 1,500 ft. long.

Northwest.—Existing Roads.

DULUTH & IRON RANGE.—This company has decided to build a branch from a point on the main line near Knife River, Minn., northwest to the Mesaba Range.

CHICAGO, MILWAUKEE & ST. PAUL.—The Eau Claire, Chippewa & Superior Ry. Co. has been chartered in Wisconsin, probably in the interest of this road, to build a line from Chippewa Falls to West Superior, Wis. It is stated that construction will be commenced in the spring.

BURLINGTON, CEDAR RAPIDS & NORTHERN.—This company has purchased the partly completed roadbed and right of way of the Davenport, Iowa & Dakota R. R., and will, it is stated, take steps toward constructing the line in whole or in part.

GREAT NORTHERN.—The branch from St. Hilaire to Red Lake Falls, Minn., 10¼ miles, has been completed.

SIOUX FALLS, YANKTON & SOUTHWESTERN.—The survey has been completed for the extension of this railway northeast from Sioux Falls to Yankton, S. Dak.

Southwest.—Existing Roads.

LOUISIANA, ARKANSAS & MISSOURI.—A press dispatch from Vicksburg, Miss., dated Dec. 12, says: "Capt. H. P. Wells, of Delhi, La., states that arrangements are now almost completed for building that portion of the Louisiana, Arkansas & Missouri R. R. between Trippe, Ark., and Bryant City, La. A million dollars has been promised for the purpose, and Pres. H. M. Hoyt is satisfied the remaining sum necessary to complete this part of the road, $800,000 will be subscribed shortly. The contract will be let this spring. He is confident that construction will be pressed as rapidly as possible. This line is designed to connect Alexandria, La., and Brinkley, Ark., and will pass through Delhi.

MERCHANTS' TERMINAL R. R. CO.—This company is reported to be making surveys for a belt line from its bridge in North St. Louis, Mo., to the South End.

NORTH GALVESTON, HOUSTON & KANSAS CITY.—An arrangement has been entered into between this company and the La Porte, Houston & Northern R. R. Co., to connect their lines by building a 15-mile link between North Galveston, and Clear Creek, Tex. The work will be divided between the two companies, and is already in progress on a portion of the line.

KANSAS CITY, NEVADA & FT. SMITH.—A project is on foot to consolidate this and the Kansas City, Ft. Smith & Southern, and the Texarkana & Ft. Smith railways, and build connecting links, thus making a through line from Kansas City, Mo., to Texarkana, Tex.

SOUTHWESTERN, ARKANSAS & INDIAN TERRITORY.—This company, which built a line from Oklona, to Hebron, Ark., 23 miles, in 1888, has nearly completed an extension from Hebron to Antoine, Ark., 6 miles. It is also stated that surveys have been completed for a further extension from Antoine to the center of Pike Co., Ark., about 12 miles. Ch. Engr., N. S. Woods, Arkadelphia, Ark.

Projects and Surveys.

DENISON & NORTHERN.—This company, which was chartered in February, 1891, to build a railway from the Red River to Kentucky Town, in Grayson Co., Tex., has called a meeting of stockholders for Jan. 27, 1893. The purpose of the meeting is to increase the capital stock of the company from $200,000 to $2,500,000, and to authorize an issuance of bonds to that amount, necessary for constructing, completing, improving and operating its railway. J. H. Fairbanks is Secretary.

INTEROCEANIC.—S. L. Shellenberger, South McAlester, I. T., Pres., is reported as saying that construction will begin on this railway early next year. The company was chartered in October, 1891, for the purpose of building a railway from Memphis, Tenn., to Hartford, Ark.

OKLAHOMA MIDLAND.—This company has been chartered in Oklahoma Territory to build a railway from Joplin, Mo., southeast across the Indian Territory to the Texas line in Wilbarger Co.

ARKANSAS MINERAL BELT.—At a recent meeting of the directors it is reported that final arrangements were made for building this road. The company was chartered in October, and preliminary surveys have been made for a line from Little Rock, Ark., to West Plains, Mo., 175 miles. The locating surveys are to be begun in January, 1893, and it is hoped to have the line completed sometime in 1893. Pres., C. P. Huntington, New York city.

Rocky Mt. and Pacific.—Existing Roads.

DENVER & RIO GRANDE.—The contractors, Levi & Moore, have a force of about 200 hands at work on the branch from Crested Butte, Colo., west to the coal lands of the Colorado Fuel & Iron Co., about 10 miles. The contract calls for the completion of the line by May 1, 1893.

EL PASO & NORTHERN.—In regard to the resumption of work on this railway, noted in our issue of Dec. 8, Morris R. Locke, of Jerseyville, Ill., writes the "Manufacturers' Record" as follows: "It is expected that work will be resumed on the road, and that it will be completed from El Paso, Tex., to White Oaks, N. M., as speedily as possible. There are ten miles completed, El Paso to Lanoria, Tex., and ten miles graded Lanoria to the New Mexico line."

WYOMING & UTAH.—Chartered in Wyoming and Colorado to build a railway from Casper, Wyo., to Ogden, Utah, with branches to Rawlins and Lander, Wyo. The capital stock is $10,000,000.

COLORADO MIDLAND.—The survey for the branch to the Cripple Creek mines, Colorado, has been completed. The line will be 31 miles long, including 8 miles of branches to the Deerhorn and Gold King mines, and will be narrow gage, 3 ft. The maximum grade is 5%. A force of about 150 men are now at work on the line. It is possible that the Line will be completed by April 1, 1893.

UNION PACIFIC SYSTEM.—It is announced that considerable work will be done on the Colorado lines of the system during the coming year. The work is mostly in laying new steel rails and otherwise improving the track.

SOUTHERN PACIFIC.—A correspondent writes us as follows: "The firm of Geo. Stone & Co., of San Francisco, Cal., have the contract for building the 16-mile extension of the Southern Pacific Coast R. R., from Santa Margarita to San Luis Obispo, Cal. There is a large amount of heavy work on the line, including seven tunnels whose lengths are 2,500 ft., 1,570 ft., 480 ft., 580 ft., 250 ft., 875 ft. and 704 ft. From Santa Margarita the line follows a branch of the Salinas River, three miles, with a maximum grade of 2%, to the Divide (elevation 1,300 ft.), between Santa Margarita and San Luis Obispo. At this point is located the first and longest tunnel. From here the line runs down along the side of the mountain 12 miles, with a 2% grade, to the bottom, within about a mile of San Luis Obispo. On this 12 miles are located the other six tunnels. From San Luis Obispo to Eliwood, where the line connects with the terminus of the line north of Los Angeles, the distance is about 110 miles. This line saves the long, heavy grades through the Tehachapi Pass, and the hot, dusty ride to Mojave, and through the San Joaquin Valley. It will probably take the most of the tourist travel between San Francisco and Southern California, as from the line most of the pleasure resorts, such as San Jose, Santa Cruz, Monterey, Pacific Grove, Paso Robles Springs, etc., are reached direct or by short branches."—The following new track has been laid on the Southern Pacific lines in California from Jan. 1 to Dec. 1, 1892: Bakersfield

to Asphalto, 47.39 miles; Colis to Fresno, 15.15 miles; Redlands Junc. to Crafton, 5.61 miles; Santa Monica to Santa Monica Canyon, 2.83 miles; San Bruno to South San Francisco, 2.16 miles; Baden to South San Francisco, 1.51 miles.

EUREKA & EEL RIVER.—This California company has completed surveys for a 3-mile extension of its railway.

Projects and Surveys.

NEVADA SOUTHERN.—This company has been organized to build a railway from Goff's Station, about 20 miles east of Needles, Cal., to the New York and Vanderbilt mining districts, a distance of a little over 40 miles. The first 30 miles are to be built at once, the rails having been already purchased, which bring the line to the New York mines. Later the line will be extended to the Vanderbilt mines, and ultimately to Good Springs, Nev. The officers of the company are: Pres., J. E. Blake; Secy. and Treas., Geo. C. Manley, and Gen. Man., R. S. Selbert; all of Denver, Colo.

SEATTLE & SOUTHEASTERN.—A Seattle, Wash., paper says: "A company will soon be incorporated to build a road under the name of the Seattle & Southeastern R. R., in a generally southeasterly direction from this city, to connect with the projected extension of the Burlington system to the Sound. The arrangements were made with local capitalists by the representative of the Burlington who recently visited the Coast, and preparations are being made, but it is impossible to learn who are the local men interested or what route is proposed for the line. All that can be learned positively is that such a road is projected, and that it is a Burlington enterprise."

Foreign.

MEXICO.—A concession has been granted to United States capitalists for a railway from Esperanza to Suchil. It is stated that the concessionaires have deposited $500,000 as a guarantee for the construction of the line.

ELECTRIC RAILWAYS.

SYRACUSE, N. Y.—The Syracuse Storage Battery Co. is reported as having made satisfactory runs with its street car motors. Pres., R. V. Miller; Secy., G. S. Puck.

ROCHESTER, N. Y.—The Rochester, Windsor Beach & Irondequoit Bay Electric Ry. Co. has applied for a franchise, and the matter will be considered Jan. 10. Pres., S. Remington.

LOCKPORT, N. Y.—A franchise for an electric railway has been granted to the Lock City Electric Ry. Co. Work to be commenced by May and completed by September, 1893.

ALTOONA, PA.—Altoona & Logan Valley Electric Ry. Co.; capital stock, $175,000, with $35,000 paid in; Pres., John Lloyd.

BELLWOOD, PA.—Juniata Valley Electric Ry. Co.; capital stock, $100,000, with $20,000 paid in; line from Bellwood to Altoona; Pres., Fleming Holliday.

WASHINGTON, D. C.—The Washington & Marlborough Electric Ry. Co., $250,000, has been organized by Charles E. Creecy, A. M. Bliss and John W. Bell.

WAUSAU, WIS.—A franchise for an electric railway has been applied for by J. D. Ross, B. E. Jones and Hiram Dunfield.

SAN FRANCISCO, CAL.—Four electric railways aggregating 20 miles in length, are to be built next spring by the Southern Pacific syndicate which controls most of the street railways.

HORSE AND MOTOR RAILWAYS.

LEBANON, PA.—Lebanon Valley Traction Co.; Lebanon to Annville; $10,000, with $2,000 paid in; Pres., H. H. Kreider, Annville, Pa.

PHILADELPHIA, PA.—Philadelphia, Castle Rock & West Chester Ry. Co.; $90,000, with $18,000 paid in; Pres., J. U. M. Shiner.

CHICAGO, ILL.—Chicago & Suburban Transit Co.; $1,000,600; C. Thorbjornson, W. W. Riley and Andrew Shulson.

TACOMA, WASH.—Rapid Transit Co.; $700,000; W. R. Rust, Frank Allyn and G. H. Wheeler.

HIGHWAYS.

NEW YORK.—The commissioners, E. R. Safford, of Glens Falls; Lemuel Woodward, and Royal Smith, of Warrensburgh, have been to Chester to pass upon the necessity for a new highway. Counselor J. H. Cunningham represents the town and some of the individual property owners.

PENNSYLVANIA.—Darby township, Philadelphia, has made arrangements to borrow $25,000 for the improvement of the roads in Clement M. Biddle's district.

NEW JERSEY.—Proposals are invited for the construction of a macadamized road in Middlesex Co., beginning at Holly's corner, extending in a southerly direction to Metuchen, a distance of about 3½ miles, at the intersection of Middlesex turnpike. Bids will be received until Dec. 27 at Campbell's Hotel, near Plainfield, N. J., at which place they will be opened by the Road Committee of the Board of Chosen Freeholders and the award of the contract will be made to the lowest responsible bidder with adequate security, as soon thereafter as practicable. The bids must be for the furnishing of all the material and labor necessary to the completion of said road in accordance with the specifications, at a price per lineal foot. Work to be completed on or before July 1, 1893. The specifications can be seen at the office of H. Brewster Willis, 384 George St., New Brunswick, N. J.

MISSISSIPPI.—Proposals to raise bed of road No. 34 near Redwood above high water mark, and to raise bed of road No. 41, will be received at the office of the Clerk of the Board of Supervisors of Warren Co., Vicksburg, Miss., until Jan. 2, 1893. Plans and specifications are on file in the office of J. D. Laughlin.

WATER-WORKS.

New England.

RAYMOND, N. H.—A town meeting will be held Dec. 24 to see what action will be taken regarding a water supply for fire protection. Heavy fire losses have recently been sustained.

LOWELL, MASS.—Dec. 29 the city will open bids for 100 tons 6-in., 150 tons 8-in., 100 tons 10-in., 300 tons 12-in., 300 tons 16-in., 300 tons 20-in., 600 tons 30-in. cast iron pipe. Specifications can be obtained on application to the Water Board.

MITTINEAGUE, MASS.—Works are talked of. A connection may be made with the Ludlow works.

NEWBURYPORT, MASS.—Mayor O. F. Gurney has applied to the legislature for authority to build works. A company supplies the place.

NORTH ANDOVER, MASS.—Dec. 28 a town meeting will be held to discuss proposed works. A supply may be introduced from Lake Cochichewick.

NORWOOD, MASS.—The Water Commissioners have applied to the legislature for authority to supply East Dedham and East Walpole.

PROVINCETOWN, MASS.—The people voted 197 to 195 in favor of works.

SPRINGFIELD, MASS.—The Water Commissioners have recommended a new supply main from the Ludlow reservoir; estimated cost, $363,081.

WOONSOCKET, R. I.—The "Reporter" favors filtration.

WOODBURY AND HOTCHKISSVILLE, CONN.—A petition for authority to build works will probably be made to the next legislature.

Middle.

ALBANY, N. Y.—The Water Board has awarded the contract for 820 tons of 4 to 20-in. cast iron pipe, and 70,000 lbs. of special castings to R. D. Wood & Co., Philadelphia, for $21,852.

BATAVIA, N. Y.—Aldermen Manning, Perrin and others have been appointed a committee to consider an improved supply to consist of filtered water from Tonawanda Creek.

BROOKLYN, N. Y.—Chf. Engr. Van Buren has recommended new storage ponds, pumping engines and a 5-ft. conduit to extend from Rockville Center to the pumping station at Ridgewood or Spring Creek; estimated cost, $3,205,000.

BABYLON, N. Y.—It is reported that the Sumpwamp Water-Works Co. has been incorporated; $25,000; W. F. Norton, L. H. Fishel, and others, of Babylon.

HIGHLAND, N. Y.—Works are talked of.

KEYPORT, N. J.—Bids for furnishing, laying and setting cast iron pipe, hydrants, valves, special and hydrants, are wanted until Jan. 12, and until Jan. 19 for constructing pumping plant, stand-pipe and pump well and sinking artesian wells. Address Water Commissioners, or Engrs. I. S. Cassin & Son, Philadelphia.

ALTOONA, PA.—Bids for a new reservoir have been received as follows:

R. A. & B. E. Malone, Lancaster	$165 000
Jutte & Foley, Pittsburg	246.328
Drake, Strattan & Co., Ltd., Philadelphia	182 000
Bowman Bros., McKeesport	234.500
J. M. Campbell & Co., Altoona	302,678
Thomas Collins, Bellefonte	160.900
Coon & Mooney, Wilkes Barre	147 045
Continental Construction Co., New York	162.191
Owen Patterson, Baltimore	165.500

MAUCH CHUNK, PA.—The Hazel Water Co. has been incorporated; $5,000; Treas., Daniel G. Baird.

McKEESPORT, PA.—The Water Commissioners have awarded the contracts for two pumps, each of a capacity of 3,000,000 gallons, to the Blake Pump Co., at $21,500. One pump is to be in position within three months and the other one a month later. The bids received were as follows:

	Stroke.	Price.
Blake Mfg. Co., Cambridgeport, Mass.	36-in.	$21,500
Barr Mfg. C., Philadelphia, Pa.	24-in.	18.500
" " "	"	19.200
Gordon Mfg. Co., Hamilton, O.	36-in.	21.925
Hughes Mfg. Co., Cleveland, O.	36-in.	20.999
Hall Pump Co., Allegheny City	30-in.	17.600
Holly Pump Co., Lockport, N. Y.	24-in.	29.000
Knowles Mfg. C., Boston, Mass.	24-in.	20.000
" " "	36-in.	22 000
Snow Pump Co., Buffalo, N. Y.	24-in.	23.500
" " "	30-in.	27.500
Worthington Mfg. Co., New York	24-in.	21.875
Wilson-Snyder Co., Pittsburg, Pa.	24-in.	14 200
" " "	30-in.	16.000
" " "	36-in.	17.300

WOLMESDORF, PA.—A company has been organized by W. G. Moore.

WILMINGTON, DEL.—It is stated that a filtering plant will be built after plans by Geo. Sellers. Water will be brought in contact with iron scraps aerated, then filtered through sand. Estimated cost, $50,000.

Southern.

FAYETTEVILLE, N. C.—It is reported that works will be built by Ferris & Richards, Jersey City. There is one private plant here already.

MILAN, TENN.—Legislative authority to build works may be sought.

DANVILLE, KY.—Engr. John McLeod has recommended that surveys be made to determine the feasibility of obtaining a water supply from Harrod's Run or Dix River.

North Central.

CLEVELAND, O.—Bids are wanted until Dec. 28 for setting three 8×16-ft. tubular boilers and equipping them with smoke preventing devices.

WARREN, O.—Attempts to secure good water from artesian wells not having been successful, a filtering plant may be established.

ZANESVILLE, O.—The Water-Works Trustees have been petitioned to erect a 30×100-ft. stand-pipe.

EDINBURG, IND.—Plans for works to be completed about July 1, 1893, are being made by Engr. J. J. Hainsworth, Franklin, Ind.; estimated cost, $20,000.

LA GRANGE, IND.—It is said that $20 000 water bonds will soon be on the market, and that it is hoped works will be tested by July 4 next.

LEBANON, IND.—The Howe Pump & Engine Co. will make an estimate on the cost of water and electric lighting plants.

FAIRFIELD, ILL.—The Fairfield Water-Works Co. has been incorporated; $12,000.

Northwestern.

DILLON, MONT.—Works are proposed, but a charter revision seems necessary before the city can build them.

DOON, IA.—It is said that a move for works is being made.

Southwestern.

COLUMBIA, MO.—Dec. 17 the people ratified by vote the franchise recently granted to W. T. Anderson, St. Louis. It is said that construction will be started at once.

LARENDO, TEX.—A steel tank and a tower is said to be projected.

SULPHUR SPRINGS, TEX.—It is said that works will be built.

Pacific.

DAVENPORT, WASH.—A recent fire has caused water-works discussions.

PORTLAND, ORE.—The relative merits of cast and wrought iron pipe for the new supply from Bull Run are being considered. Including dams, reservoirs, pipe lines and accessories it is estimated that the new works, complete, will cost $2,200,000.

ARTESIAN WELLS.

KEYPORT, N. J.—Bids for sinking wells are wanted until Jan. 12. Address Water Commissioners.

MOORHEAD, MINN.—Bids for sinking a well are wanted until Jan. 2. Cy. Recorder, A. J. Wright.

SCOTLAND, S. DAK.—It is said that the Council has decided to sink an 8-in. well for a water supply.

CORSICANA, TEX.—A company may be organized to sink wells here. Water has been found at a depth of 2,500 ft.

EL PASO, TEX.—The lowest of five bids for sinking an artesian well was from Bascom & Lamour, $8.50 per foot for 1,500, the city to have the option of ordering the well continued to a depth of 3,000 ft. at the same rate. If at any depth between 2,500 and 3,000 ft. the contractors found it physically impossible to proceed further the contractors would receive $8.50 per ft. for the depth reached less $3.50 per ft. for the difference between the depth reached and 3,000 ft.

IRRIGATION.

GOLDENDALE, WASH.—The citizens propose to build an irrigation ditch.

NEW COMPANIES.—Alliance Irrigating Canal & Water Power Co., Camp Clarke, Neb.; $10,000. Willow Park Reservoir Co., Estes Park, Colo.; $100,000; Theo. Wayte, J. A. Thatcher, Cerillos Water & Irrigation Co., Cerillos, N. M.; $30,000; T. F. Moore, N. B. Shields, A. F. Easley, Grapevine Ditch Co., Eddy, N. M.; $10,000; Thos. J. Fletcher, John T. Lucas, High Land Irrigation Co., Las Cruces, N. M.; J. H. Nations, W. A. Irvin, Eagle Water & Ditch Co., Pendleton, Ore.; $20,000; D. W. Bailey, T. F. Rourke, W. J. Furnish, Clear Lake Power Co., Lake Co., Cal.; $5,000,000, of which $5,000 is subscribed; Directors, Louis T. Haggin, Alfred Wheeler and others, Canyon Hill Ditch Co., Caldwell, Idaho; $10,000, Liberty Park Irrigation Co., Liberty Park, Idaho; $10,000, Mount Nebo Reservoir & Canal Co., Salt Lake City, Utah; $300,000; W. H. Tibbals, Pres.; O. R. Young, Man.

SEWERS.

PROVIDENCE, R. I.—The Board of Aldermen has voted to petition the next legislature for authority to borrow $2,500,000, to be expended as follows: Sewers, $1,500,000; highway work, $500,000; water-works, $500,000.

SOUTHINGTON, CONN.—The borough will petition the legislature for authority to put in a sewerage system.

HERKIMER, N. Y.—At the special election referred to in our issue of last week, the vote was 151 to 41, in favor of sewers.

JAMESTOWN, N. Y.—The citizens voted by a majority of 774 to issue bonds for $100,000 for the proposed sewer system.

NEW YORK, N. Y.—Bids will be received until Dec. 29 for four sewers, including two in Wards 23 and 24.

ROCHESTER, N. Y.—The lowest bid for section 4 of the East Side trunk sewer was that of T. F. Moore, Buffalo, $65,710.

ETNA, PA.—The Councilmen are discussing the need of a system of sewers. Much sickness is reported.

BRIDGEPORT, W. VA.—Plans for a sewerage system have been prepared by Hanlon Bros., Media.

COLUMBUS, GA.—The City Council will receive bids until Dec. 28 for terra cotta drain pipe, brick, grates and castings, and other supplies, during 1893.

NEWPORT, KY.—Bids are asked until Dec. 29 for brick and pipe sewers in three streets. B. R. Morton, Cy. Engr.

IRONTON, O.—The sale of sewer bonds for $20,000 has been authorized. A 30 to 36-in. brick sewer has been declared necessary in one street.

TOLEDO, O.—The City Clerk will receive bids until Dec. 26 for 12 brick sewers, nearly all being 24-in. with 4-in. shell.

CHICAGO, ILL.—The County Court has decided the Wentworth Ave. sewer assessment case in favor of the city. The proposed sewer will cost about $1,000,000, and will drain about nine square miles of territory within the city limits, extending from 87th St. to the Calumet River, and a mile or more on either side of Wentworth Ave.

TAYLORVILLE, ILL.—J. Z. Michels, Cy. Engr., is preparing plans for a system of sewerage.

LOS ANGELES, CAL.—Contracts for the outfall sewer have been awarded as follows: Section 1, John Rebman, $12,012; sections 2, 5, 7 and 9, Frisk Bros., $105,492; section 4, J. L. Mansfield, $26,830; section 8, Hughes & Meyer, $24,602.

STREETS.

JAMESTOWN, N. Y.—The village of Falconer is desirous of paving Second St., a distance of three miles, to Jamestown. The citizens are also considering the paving of the principal business streets of the village.

NEW YORK, N. Y.—The Commissioner of Street Improvements in Wards 23 and 24 will receive bids until Dec. 29 for grading, paving with trap-blocks, etc., in one street.

SYRACUSE, N. Y.—We are informed by Henry G. Allen, Cy. Engr., that a contract for paving on Warren and Adams Sts., about 6,000 sq. yds., with Trinidad asphalt has been awarded to the Syracuse Improvement Co., at $16,677. The Warren-Scharf Asphalt Paving Co. bid $19,477. This makes a total to date of 6.74 miles of paving, to cost $427 777, for which contracts have been made, the work to be done next season. The kinds of pavement are block sandstone, Trinidad asphalt and brick.

YORK, PA.—The contract for paving about 10,000 sq. yds. with asphalt blocks has not been awarded and the work will be readvertised. Bids were received

at from $2.43 to $2.97 per sq. yd. and the committee recommended that the award be made to the highest bidder.

NEWPORT, KY.—Bids are asked until Dec. 20 for paving in two streets with brick; estimates, $35,000 and $36,000. B. R. Morton, Cy. Engr.

OWENSBORO, KY.—At a public meeting Dec. 16 the citizens voted in favor of issuing bonds for $200,000 for paving the streets with brick.

BEREA, O.—The Village Clerk will receive bids until Jan. 16 for grading, curbing, and paving with sandstone, or brick.

CANTON, O.—The Canton Street Construction Co. has been incorporated to do street improvement work in this city; capital stock, $900,000.

DAYTON, O.—The City Council has ordered the paving of Wilkinson St. The estimate is as follows: First class Medina block, $35,700; Hayden block, $28,260; Hallwood block, $28,200; asphalt, $29,135; brick, $25,635; sewers, catch basins and culverts, $500.

TOLEDO, O.—Contracts have been awarded as follows: Warren-Scharf Asphalt Paving Co., asphalt, $60,131; C. W. McKinney, fire brick, $18,417; Wernert & Son, fire brick, $14,498; Wm. McMahon, fire-brick, $37,019.

NEW ALBANY, IND.—The Mayor will receive bids until Jan. 2 for paving Pearl St. with vitrified brick.

CANTON, ILL.—We are informed by J. C. Thompson, Jr., Cy. Clk., that bids will soon be asked for about two miles of brick paving.

DAVENPORT, IA.—The Committee on Paving has presented a list of nine streets to be paved with brick. The work includes 30 blocks, 21.5 intersections, and 2 alleys, and bids will be asked for the work.

ELECTRICAL.

MOODUS, CONN.—It is reported that bids will soon be asked for lighting this place by electricity.

HAMBURG, N. Y.—The Hamburg Water & Electric Light Co. is preparing to put in an electric light plant. Two engines and two dynamos will be required, and these will be placed in the pumping station, which was built large enough for this purpose.

NEW YORK, N. Y.—Contracts have been awarded as follows: U. S. Illuminating Co., 351 lamps, at 40 cts. each per lamp; Brush Co., 232, at 40 cts., and 72 at 45 cts.; Thomson-Houston Co., 217 at 40 cts.; Mt. Morris Co., 314 at 40 cts.; Harlem Lighting Co., 194 at 40 cts., and 19 at 50 cts.; Manhattan Co., 52 at 40 cts; North River Co., 633 at 45 cts. These prices are now being paid. Several other bids were received from these same companies, but they were either rejected or taken under consideration.

LAUREL, MD.—The Electric Light, Power & Heat Co. has completed its organization, and contracted with the Ries Electric Specialty Co., Baltimore, for the installation of a plant. The city has contracted for 100 incandescent lights of 32 c. p. each, at $1,2.0 per year. W. E. Gilbert is president and L. A. Ellis manager of the company.

COLUMBUS, GA.—The City Clerk will receive bids until Dec. 28 for about 112 arc lights of 2,000 c. p. each; also for incandescent lights, for one year.

MARIETTA, O.—The City Clerk will receive bids until Jan. 6 for the purchase of the entire electric light plant of the city, each bid to contain the price per lamp at which the bidder will contract with the city for arc street lighting for ten years.

ANDERSON, IND.—The City Council has contracted with the Western Electric Co., Chicago, Ill., for an electric light plant to cost about $25,000. It will have 150 arc lights.

DETROIT, MICH.—The only bid received for 150 arc light towers was that of the Commercial Electrical Co., $746 per tower. The Mayor and others have requested that the City Counselor prepare a bill, to be introduced into the legislature to allow the city to operate an electric light plant.

HILLSDALE, MICH.—We are informed by Geo. A. Mark that bids will be received until Dec. 26 for an electric light plant, as follows: 150-HP. steam engine, two dynamos of 750, 16-c. p., 50-volt incandescent lamps each; one arc light dynamo, and 50 single carbon lamps, etc.; plant to be complete and ready to be used within 90 days after award.

MASON, MICH.—The City Clerk will receive bids until Jan. 2 for lighting the city with arc electric lights.

JERSEYVILLE, ILL.—The contract for electric street lighting has been renewed at $2.50 per month for each light of 32 c. p. The present price is $3 per month.

MADISON, NEB.—The citizens have voted to issue bonds for an electric light plant.

EDINA, MO.—The citizens have voted to light the streets by electricity.

LONGVIEW, TEX.—A franchise has been granted to the Electric Light & Power Co., and a plant will be put in at once.

WACO, TEX.—The Waco Water Power & Electric Co. has been incorporated by S. W. Slayden, W. Cameron and S. A. Hobson, with a capital of $50,000, and will commence at once the construction of a large dam in the Brazos River to generate electricity for light and power purposes.

MONTCLAIR, COLO.—The Montclair Electric Light Co. is building an additional boiler room to its works, and has in contemplation an increase of its plant and quite an addition to its buildings, work on which will be started early next year.

NEW COMPANIES.—Dravosburg Light, Heat & Power Co., Dravosburg, Pa.; $20,000; M. S. Baum, Luzerne Heat & Power Co., Luzerne, Pa.; $2,0 0; Treas., Thos. R. Phillips. Elwood Electric Light Co., Elwood, Pa.; $1,000; Treas., S. A. Roclops. Ambler Electric Light, Heat & Power Co., Ambler, Pa.; $15,000; Treas., H. G. Griffith. Boyerstown Heat & Power Co., Boyerstown, Pa.; $1,000; Treas., J. M. Zook, 333 Walnut St., Philadelphia. Wachtel Electrical Mfg. Co., Newark, N. J.; $50,000; C. W. Wachtel, D. C. Bauer, A. A. Geiger.

CONTRACT PRICES.

GRADING.—Boston, Mass.—The Park Commissioners have awarded the contract for grading on the Parkway between Washington and Forest Hill Sts. to Newell & Snowling as follows: 7,000 cu. yds. of loam stripping and 6,000 cu. yds. of earth excavation, 24 cts. per cu. yd.; 2,000 cu. yds. of filling, 00 cts. per cu. yd.

SEWERS.—Kansas City, Mo.—The itemized prices of the contract for the extension of the O. K. Creek sewer, which we noted last week as awarded to Chas. Schestedt & Sons at $20,441, are as follows: $20.4 ft. of 15½-ft. brick sewer, at $26.85; 20 ft. of special connections, at $27.25; 220 ft. of double culvert, at $27.40; 2 manholes, at $35; 10 cu. yds. of cut stone masonry, at $7.75; 5 cu. yds. of rubble masonry, at $4.25; 10 cu. yds. of concrete, at $5; 10 cu. yds. of rock excavation, at $3.15; 20,000 ft. of lumber, at $20 per M.; 6,873 lbs. of cast iron at 2¾ cts.; 40 lbs. of wrought iron, at 4 cts.

PAVING BLOCKS.—Bangor, Me.—The following bids were received for furnishing the city with granite paving blocks during 1893: Jewell Granite Co., Bangor, $54 per M. for the regulation size, and $35 for the 4×4 ins. special size; David Brown, Dedham, $54 and $35; Mount Waldo Granite Co., $60 and $43.50.

ROADS AND SEWERS.—Brooklyn, N. Y.—The Board of Supervisors has opened bids for the construction of roads and sewers at St. Johnland estimated to cost between $250,000 and $300,000. The bidders were as follows: 1, M. J. Dady; 2, Edward Freel; 3, J. W. Birkett; 4, J. H. O'Rourke; 5, I. A. Nevins; 6, Thos. McCann.

Excavation.	1	2	3	4	5	6
per cu. yd.	$.18	$.20	$.05	$.05	$.20	$.25
Filling, per cu. yd.....	.18	.08	.17	.20	.20	.25
Macadamizing per sq. yd..	.75	.87	.74	.80	1.75	1.60
Brick masonry per cu. yd..	10.00	10.00	12.00	10.00	9.00	12.00
Concrete, per cu. yd.....	5.50	5.50	6.50	5.00	4.00	5.00
Curbing, per lin. ft.....	.85	.53	.74	.85	.90	.75
9-in cement pipe, per ft..	1.00	.60	.50	.60	.80	.40
6-in. cement pipe, per ft..	.50	.40	.45	.50	.60	.20
18-in. cement pipe, per ft..	1.50	1.40	1.18	1.20	1.62	1.50
Catch basins, each	30.00	40.00	15.00	35.00	50.00	40.00
Manholes, each	40.00	30.00	15.00	40.00	50.00	40.00
Flagging, per sq. ft.....	.25	.22	.21	.25	.37	.25
Gutter stone, per sq. yd..	2.45	1.80	1.98	2.10	2.35	.40
Shoulder stone, per lin. ft..	.60	.10	.20	.50	.35	.70
Moving old building ...	1.200.00	250.00	200.00	250.00	350.00	500.00

WELL.—El Paso, Tex.—The following bids have been received by the City Clerk for boring an artesian well: McLeod Artesian Well Co., Keokuk, Ia., $10 per ft. for the first 1,500 ft., then $11 per ft. for 500 ft., $12.50 per ft. for 500 ft., and $15 per ft. for 500 ft.; American Well Co., Martin, Tex., $9,000 for the first 1,000 ft., $10,000 for next 1,000 ft., and $11,000 for the third 1,000 ft.; Richard Ritter, Sedalia, Mo., $13.25 per ft. for 1,500 ft., $17.500 for 2,000 ft., and $8.75 per ft. for the remainder of the distance; J. P. Miller & Co., Chicago, $12 per ft. for the first 1,000 ft., $12.50 for the next 100 ft., then 50 cts. per ft. additional for each 100 ft. to 1,500, 75 cts. to 2,000 ft., $1 to 2,500 ft., and $1.25 to 3,000 ft.; Bascomb & Lamour, El Paso, $9.50 per ft., the city to pay for 1,500 ft., whether that depth is necessary to procure the supply of water or not.

DREDGING.—Detroit, Mich.—Bids have been opened by Gen. O. M. Poe, U. S. Engr., for a 20 and 21-ft. channel between Chicago, Duluth and Buffalo. The work is divided into eight sections, and the total appropriation is $3,340,000. The range of the bids was as follows:

Section 1, at Round Island Shoals, 90,000 cu. yds.; lowest bid, R. J. Cram, Detroit, 44 cts. per cu. yd.; highest bid, 87 cts.

Section 2, Little Mud Lake, 380,000 cu. yds. of sand, gravel, etc.; lowest bid, C. E. Mitchell & Co., Ludington, 25.9 cts. per cu. yd.; highest bid, 42 cts.

Section 3, Sailors' Encampment, 90,366 cu. yds. of rock; lowest bid, John Hickler, Buffalo, N. Y., $2.43 per cu. yd.; highest bid, $5.

Section 5, foot of Lake Huron, 256,000 cu. yds. of sand, clay, etc.; lowest bids, McCollum & Lee, Essexville, Mich., and R. J. Cram, Detroit, each bid 58 cts. per cu. yd.; highest bid, $1.30.

Section 6, St. Clair Flats, 950,000 cu. yds. of clay and sand; lowest bid, Jas. Rooney, Toledo, O., 16.5 cts. per cu. yd.; highest bid, 34 cts.

Section 7, Grosse Point Flats, 1,200,000 cu. yds. of clay, sand, etc., for minimum width of 300 ft., or 2,000,000 cu. yds. for width of 800 ft., the width to depend on the price; lowest bid, Brevmann Bros., Toledo, O., 14¾ cts. per cu. yd.; highest bid, 43 cts.

Section 8, mouth of Detroit River, 411,000 cu. yds. of clay, sand, etc., for width of 300 ft., or 1,086,000 cu. yds., for width of 800 ft.; lowest bid, L. P. & J. A. Smith, Cleveland, O., 18 cts. per cu. yd.; the next bid was 28 cts., and the highest, 74 cts.

MISCELLANEOUS.

POWER STATION.—Austin, Tex.—The Board of Public Works will receive bids until Jan. 4 for the superstructure of an hydraulic and electric power station. J. T. Fanning, Minneapolis, Minn., Consult. Engr.

DOCK.—Duluth, Minn.—Plans for the extension of the Duluth & Winnipeg ore dock are nearly completed, and the contract will be let at once.

CITY HALL.—Jersey City, N. J.—Owing to the failure of C. A. Bouton & Co., New York, to whom the contract for the city hall was awarded at $231,750, to secure the required sureties, the commissioners have decided to readvertise the work.

DREDGING.—New York, N. Y.—The Department of Docks will receive bids until Dec. 29 for dredging about 45,200 cu. yds. in the North River.

GARBAGE CREMATORY.—Rockford, Ill.—The Health Committee has recommended that $10,000 be appropriated for the erection of a city garbage crematory. Most of the aldermen are reported as in favor of the proposition.

GAS LIGHTING.—New York, N. Y.—Contracts have been awarded for gas lights as follows: Equitable Co., $12 a year for each city lamp on its line; Standard, $13.04½ for each lamp; Mutual and Consolidated Cos., $17.50; Central Co., for lights in Ward 23, $27; Northern & Yonkers Co., in Ward 24, $28.

GAS COMPANIES.—American Gas Co. of New Jersey, Camden, N. J.; $500,000; G. G. Ramsdell, M. W. Stroud, Philadelphia, and W. W. Cox, U. S. Gas & Fuel Co., Chicago, Ill.; $2,800,000; Edward A. Miller, Calvin C. March, and others.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Brooks Locomotive Works, Dunkirk, N. Y., have built five engines for the Burlington, Cedar Rapids & Northern, and have an order for two for the Chautauqua Lake. The Rogers Locomotive Works, Paterson, N. J., have turned out a two-cylinder compound. The Schenectady Locomotive Works, Schenectady, N. Y., have 1,800 men at work in the shops, and are turning out 25 locomotives a month; they have a large order for the Cleveland, Cincinnati, Chicago & St. Louis. The Louisville & Nashville has added a number of ten-wheel passenger engines to its equipment.

CARS.—The Ohio Falls Car Co., Jeffersonville, Ind., informs us that the following shipments have been made recently: Four coaches and 2 combination passenger and baggage cars to the Duluth, Mesaba & Northern; 2 parlor cars to the Sandusky & Columbus Short Line; 9 coaches to the Pittsburg, Fort Wayne & Chicago; 2 coaches to the Duluth & Iron Range; 100 box cars and 2 coaches to the Des Moines, Northern & Western; 10 flat cars to the Wilkes Barre & Eastern; and 30 flat cars to the Pittsburg, Shenango & Lake Erie. The company has also recently closed contracts for the following: 5 coaches and 3 parlor cars for the Cleveland, Akron & Columbus; 1 circus car for M. V. B. Wilson; 1 combination baggage, mail and express, 6 coaches, 1,250 box cars and 300 coal cars for the Ohio Southern; 30 baggage cars for the New York Central & Hudson River; 1 combination baggage and mail car for the Cincinnati, Portsmouth & Virginia; 2 caboose cars for the Ohio Valley; 700 fruit cars for the Central of Georgia; 4 coaches and 2 baggage cars for the Western of Alabama; 8 coaches for the East Tennessee, Virginia & Georgia, and 200 box cars for the Florida Central & Peninsular. The Barney & Smith Car Co., Dayton, O., has built 3 passenger and 2 combination mail, express and baggage cars for the Everett & Monte Christo. The Michigan Peninsular Car Works, Detroit, Mich., have orders on hand for about 5,000 passenger and freight cars.

RAILS.—R. B. Crawford, Atlanta, Ga., wants prices on three miles of second-hand 35-lb. steel rails and fastenings.

THE CONSOLIDATED CAR HEATING CO., Albany, N. Y., has received an order for the equipment of 100 standard passenger cars for the New York Central & Hudson River R. R. The Gilbert Car Mfg. Co., Troy, N. Y., is building these cars. This is said to be the largest single order of its kind ever given.

THE KING BRIDGE CO., Cleveland, O., has a contract from the Jacksonville & Southeastern for a bridge across the Illinois River, at Havana, Ill. It will consist of 360-ft. draw span, and 250-ft. fixed span. Mr. E. L. Corthell is engineer in charge.

THE COFFIN VALVE CO., Boston, Mass., has built a new factory at Nepouset, Mass., for the manufacture of valves, gates, hydrants, etc. The machine shop is 90×90 ft.; pattern shop, 27×90 ft., and blacksmith shop, 30×45 ft. The shops are lighted by incandescent lamps, and the motive power is furnished by a 30-HP. engine, made by the Fitchburg Steam Engine Co.

QUEEN & CO. is the new name of the firm of Jas. W. Queen & Co., of Philadelphia, re-organized as a corporation under the name of Queen & Co., incorporated, with a paid up capital of $600,000. The corporators, who are also the directors for the first year, are S. L. Fox, E. B. Fox, J. G. Gray, Wm. Biddle, Jr., J. G. Biddle and F. W. Stanwood. The manufacturing interests have largely increased in the last year or two, and the firm is now manufacturing extensively all kinds of electrical and scientific instruments and apparatus, engineering, optical and meteorological instruments, steam and vacuum gages, etc.

NEW COMPANIES.—Compressed Air Power Co., Waterville, Me.; Pres., Col. L. S. Bangs; Treas., F. A. Waldron. U. S. Wind Engine & Pump Co., Kansas City, Mo.; $75,000; H. S. Ferguson, Wm. S. Burnham and J. P. Ford. Illinois Municipal Improvement Co., Bloomington, Ill.; $50,000; C. F. Mills, E. B. Hillman and F. J. Fitzwilliam. South Bend Construction & Improvement Co., South Bend, Ind.; $10,000; Pres., Wm. H. Longley; Secy., James D. Reid.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $17 for iron, and $14.50 and $15 for steel. Pittsburg: $30; old rails, $21 for iron and $15 to $15.50 for steel. Chicago: $31 to $32.50; light rails, $32; old rails, $18.50 for iron, and $12.75 to $15 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.75 to 1.8 cts. for iron and steel; spikes, 2.05 to 2.1 cts. at mill; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 55% and 10%, and 47½% and 10% on black and galvanized butt welded; 65% and 10%, and 55% and 10%, on black and galvanized lap welded. Casing, 57½%.

FOUNDRY PIG IRON.—New York: $13.25 to $15. Pittsburg: $13 to $14. Chicago: $13.25 to $14.25.

LEAD.—New York: 3.75 cts.; Chicago: 3.72 to 3.75 cts.; St. Louis: 3.52 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.1 to 2.25 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.2 to 2.5 cts.; angles, 1.85 to 2 cts.; tees, 2.2 to 2.75 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.85 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 2.7 to 2.8 cts. for firebox. Pittsburg: beams, 2 to 2.25 cts.; channels, 2 to 2.25 cts.; angles, 1.75 to 2 cts.; tees, 2.25 cts.; Z-bars, 2 cts.; universal mill plates, 1.75 to 1.85 cts. for steel; sheared steel bridge plates, 2.1 to 2.25 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.75 cts. for tank, 2 to 2.25 for shell, 2.1 cts. for flange, 3.5 cts. for firebox, 2 to 2.1 cts. for bridge. Chicago: beams, 2.25 to 2.3 cts. for large lots, and 2.35 to 2.5 cts. for small lots; channels, 2.27 to 2.35 cts. for large lots, and 2.45 to 2.5 cts. for small lots; angles, 1.9 to 2 cts.; tees, 2.2 to 2.3 cts.; universal plates 1.95 to 2.1 cts.; steel plates (at mill), 2.5 to 2.1 cts. for tank, 2.12 to 2.25 cts. for shell, 2.2½ to 2.4 cts. for flange, 2.7 to 2.8 cts for firebox.